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Index to the

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VOLUME XXIII, 1944

TABLE OF CONTENTS

SPRING, 1944

The Directors of the American Telephone and Telegraph Company 4
The Bell System's Interest in Program Television, by *Keith S. McHugh* and *George L. Best* 7
A Review of Army and Navy Communication Facilities, by *Myron F. Dull* 13
The Telephone Remakes Naval Warfare, by *Fletcher Pratt* 24
A Bridge for Speech across Chesapeake Bay, by *Austin Bailey* 33
A Century of Electrical Communication, by *Robertson T. Barrett* 43
Radio Telephones Guide the "Blitz Buggies," by *Vance Hilliard* .. 52
Aid to Victory 63
For the Record 64

SUMMER, 1944

Telephones Are in the Fight on Every Battleground, by *Major General Harry C. Ingles* 69
The Bell System's Safety Observation Plan, by *Erle S. Miner* ... 93
We Don't Like to Say "No," by *John W. Ord* 103
Recreation Facilities for Bell System Women, by *Raymond A. Steelman* 114
When a Circus Burns, by *Raymond A. Loring* 125
"Electronics—Today and Tomorrow" (a book review), by *Harold S. Osborne* 128
Sound Movies for Sound Education 129
For the Record 132

AUTUMN, 1944

An Address before the U. S. Independent Telephone Association, by *Walter S. Gifford* 137
"I Knew Then I Was Home," by *Burton A. Hollingsworth* 147

1211062 JUN 27 1946

For Heroism, Gallantry, or Extraordinary Achievement, by *Donald S. Bridgman* 157
The Rôle of Electronics in Telephone Service, by *Austin Bailey* .. 172
A Hurricane Strikes Again, by *Judson S. Bradley* 183
Frank Baldwin Jewett: An Appreciation, by *Robert W. King* 200
William P. Banning Retires 203
For the Record 204
The World's Telephones in War-time, by *Knud Fick* 205

WINTER, 1944-1945

More and Better Telephone Service for Farmers, by *John J. Hanselman* and *Harold S. Osborne* 213
Bell Laboratories in the War, by *Oliver E. Buckley* 227
Building the West's New Telephone Route, by *Richard C. Smith* .. 241
FM Program Transmission: A Bell System Service 255
Providing Paths for Long Distance Calls, by *Ralph I. Mabbs* 263
Western Electric's First 75 Years: A Chronology, by *Frank H. Lovette* 271
For the Record 288

BELL TELEPHONE MAGAZINE

VOLUME XXIII, 1944

INDEX

A

	Issue	Page
Adair, George P.: Appointed Chief Engineer of the FCC	Sp	64
Adams, Charles Francis: Board of Directors, American Telephone and Telegraph	Sp	4
Adequate Earnings:		
Announcement on The Telephone Hour stating Company is not making normal earnings	Wi	287
Gifford, Walter S., Statement on	Sp	63
Aldrich, Winthrop W.: Board of Directors American Telephone and Telegraph	Sp	4
American Telephone and Telegraph Company:		
Annual Report for 1902, quote from	Sp	42
Annual Report, quote from, 1943	Sp	63
Board of Directors	Sp	4
"FM Program Transmission: A Bell System Service"	Wi	255
Inception of—	Sp	50
"An Address"—Gifford, Walter S.	Au	137 204
Anspach, Russell J.: Member of Bell System Communications, working with the Armed Forces	Sp	18
Arnold, H. H., General: "Communications and Air Power"	Su	91
Associated Companies:		
Filed tariffs with the Federal Communications Commission to prohibit the collection by hotels, apartment houses, and clubs of surcharges on interstate and foreign long distance telephone messages	Sp	64
National Security Award	Sp	23
Awards:		
National Security Award	Sp	23 64
Signal Corps—"Certificate of Appreciation"	Su	68 71 132
"For Heroism, Gallantry, or Extraordinary Achievement," Bridgman, Donald S.	Au	157 171

	Issue	Page
B		
Bailey, Austin: Biographical sketch	Au	135
		208
	Sp	3
Bailey, Austin: "A Bridge for Speech across Chesapeake Bay"	Sp	32
Bailey, Austin: "The Role of Electronics in Telephone Service"	Au	172
Baldwin, Raymond E. (Governor): Expressed appreciation of emergency service	Su	128
Banning, William P.: "William P. Banning Retires"	Au	203
Barrett, Robertson T.: Biographical sketch	Sp	3
		62
Barrett, Robertson T.: "A Century of Electrical Communication"	Sp	43
Barton, Enos M.: "Western Electric's First 75 Years: a Chronology" by Frank H. Lovette	Wi	271
Bell, Alexander Graham: Invention of Telephone	Sp	50
Bell, Alexander Graham: Opened long distance circuit in 1892 between New York and Chicago	Wi	277
Bell, Alexander Graham: Telephone patent granted in 1876	Wi	274
Bell, James F.: Board of Directors, American Telephone and Telegraph Company	Sp	4
Bell Laboratories:		
Application of carrier techniques to radio telephony developed	Sp	36
"Bell Laboratories in the War" by Oliver E. Buckley	Wi	227
Coaxial Cable Development	Sp	8
Cooperating with Rural Electrification Administration and private power companies in development of power-line carrier for telephone service	Wi	220
FM vehicular radio equipment developed	Sp	53
Formation and ownership of	Wi	280
Radio telephony developments	Sp	11
"The Role of Electronics in Telephone Service"	Au	172
Rubber covered wire for rural service developed by	Wi	218
"Bell System's Interest in Program Television, The" by Keith S. McHugh and George L. Best	Sp	7
		64
"Bell System's Safety Observation Plan, The" by Erle S. Miner	Su	93
Bell Telephone Magazine:		
Banning, William P., Retires	Au	203
Index available (1944)	Wi	211
Benton, William: "Sound Movies for Sound Education"	Su	129
Berle, Adolf A.: Appointed to Board of War Communications	Sp	64
Best, George L.: Biographical sketch	Sp	2
Best, George L., and McHugh, Keith S.: "The Bell System's Interest in Program Television"	Sp	7
		64
Big Business:		
Page, Arthur W., Quote from book "The Bell Telephone System," on—	Sp	12

	Issue	Page
Biography:		
Bailey, Austin	Au	208
Barrett, Robertson T.	Sp	3
		62
Barton, Enos M.: "Western Electric's First 75 Years: a Chronology" by Frank H. Lovette	Wi	271
Best, George L.	Sp	2
Bloom, Edgar S.: "Western Electric's First 75 Years: a Chronology" by Frank H. Lovette	Wi	281
Bradley, Judson S.	Au	135
Bridgman, Donald S.	Au	134
Buckley, Oliver E.	Wi	210
Dull, Myron F.	Sp	2
Fick, Knud	Au	208
Gifford, Walter S.	Au	134
Gray, Elisha: "Western Electric's First 75 Years: a Chronology"	Wi	271
Hanselman, John J.	Wi	210
Hilliard, Vance	Sp	62
Hollingsworth, Burton A.	Au	134
Ingles, H. C. (Maj. General)	Su	66
Jewett, Frank Baldwin: An Appreciation	Au	202
		208
King, Robert W.	Au	208
Loring, Raymond A.	Su	67
Lovette, Frank H:	Wi	211
McHugh, Keith S.	Sp	2
Mabbs, Ralph I.	Wi	211
Miner, Erle S.	Su	66
Morse, Samuel F. B.	Sp	43
Ord, John W.	Su	66
Osborne, Harold S.	Wi	210
Pratt, Fletcher	Sp	3
Scribner, Charles E.: "Western Electric's First 75 Years: a Chronology" by Frank H. Lovette	Wi	271
Shawk, George: Partner of firm which marked real beginning of Western Electric Co.	Wi	273
Smith, Richard C.	Wi	211
Smoot, William S.: President of Western Electric for one year	Wi	277
Stager, Anson: "Western Electric's First 75 Years: a Chronology" by Frank H. Lovette	Wi	271
Steelman, Raymond A.	Su	67
Welles, F. R.: "Western Electric's First 75 Years: a Chronology" by Frank H. Lovette	Wi	271
Bloom, Edgar S.: "Western Electric's First 75 Years: a Chronology" by Frank H. Lovette	Wi	271
Board of Directors of the American Telephone and Telegraph Company	Sp	4

	Issue	Page
Board of War Communications:		
Berle, Adolf A., Appointed to, Feb. 1	Sp	64
Willenbucher, Franz O., Named Traffic Coordinator	Sp	64
Woodward, Marion H., Named Assistant Traffic Coordinator	Sp	64
Bowman, Isaiah: Board of Directors, American Telephone and Telegraph Company	Sp	4
Bradley, Judson S.: Biographical sketch	Au	135
Bradley, Judson S.: "A Hurricane Strikes Again"	Au	182
Breese, Roy S.: Member of Bell System Communications, working with the Armed Forces	Sp	18
"Bridge for Speech Across Chesapeake Bay, A" by Austin Bailey	Sp	32
Bridgman, Donald S.: Biographical sketch	Au	134
Bridgman, Donald S.: "For Heroism, Gallantry, or Extraordinary Achievement"	Au	157
Brown, Lewis H.: Board of Directors, American Telephone and Telegraph Company	Sp	4
Buckley, Oliver E.: "Bell Laboratories in the War"	Wi	227
Buckley, Oliver E.: Biographical sketch	Wi	210
"Building the West's New Telephone Route" by Richard C. Smith	Wi	241
Business Offices:		
"We Don't Like to Say 'No'" by John W. Ord	Su	103

C

Carriers—Power-Line:		
Use in rural areas	Wi	219
A visualization of the principal physical features of the "power-line carrier" system	Wi	222
"Century of Electrical Communication, A" by Robertson T. Barrett	Sp	43
Charts:		
Effect of group size on number of circuits required	Wi	268
Farms with telephones as related to value of the farms' products	Wi	216
Hurricanes, comparison between 1938 and 1944	Au	187
Materials furnished by Western Electric Company in hurricanes of 1944 and 1938	Au	193
"Power-line carrier" system; a visualization of the principal physical features of	Wi	222
Rural and urban telephones; growth of telephones in rural areas	Wi	214
Western Electric's sales to government in 1944	Wi	286
Civilian Defense Service:		
Haskell, William N. (Lt. General)	Sp	23
Communications:		
"Communications and Air Power" by General H. H. Arnold	Su	91
"A Review of Army and Navy Communication Facilities" by Myron F. Dull	Sp	13

	Issue	Page
Communications—History:		
"An Address" by Walter S. Gifford	Au	137
"A Century of Electrical Communication" by Robertson T. Barrett	Sp	43
"Western Electric's First 75 Years: a Chronology" by Frank H. Lovette	Wi	271
"Communications and Air Power" by General H. H. Arnold	Su	91
Conservation:		
Savings made by Bell System Committee working with the Armed Forces	Sp	22
Construction:		
"Building the West's New Telephone Route" by Richard C. Smith	Wi	241
Improvements in rural construction methods	Wi	218
Cooper, Charles P.: Board of Directors of American Telephone and Telegraph	Sp	4
Craven, T. A. M.: Retired from FCC on June 30	Su	132
Crawford, David A.: Board of Directors, American Telephone and Telegraph	Sp	4

D

Davis, John W.: Board of Directors, American Telephone and Telegraph	Sp	4
De Forest, Lee (Dr.): de Forest Audion	Au	176
Diagrams:		
Application of carrier techniques to radio telephony	Sp	37
Long distance routes	Wi	265
Telephone repeater, Elementary principles of	Au	178
Vacuum tube, Elementary principles of	Au	175
Discontinuation of Service:		
"An Address" by Walter S. Gifford	Au	141
Du Bois, Charles G.: "Western Electric's First 75 Years: a Chronology" by Frank H. Lovette	Wi	271
"Duffy's Tavern," dialogue from	Sp	51
Dull, Myron F.: Biographical sketch	Sp	2
Dull, Myron F.: Member of Bell System Communications, working with the Armed Forces	Sp	18

E

Edison, Thomas A.: The Edison Effect	Au	176
Edison, Thomas: Invention of double transmitter for telegraph	Wi	272
Equipment:		
"Bell Laboratories in the War" by Oliver E. Buckley	Wi	227
Western Electric production from beginning of war to the end of 1944	Wi	285
Electronics:		
"Electronics—Today and Tomorrow" by John Mills	Su	128
"The Role of Electronics in Telephone Service" by Austin Bailey	Au	172

	Issue	Page
"Electronics—Today and Tomorrow" by John Mills (Review by Osborne, Harold S.)	Su	128
Emergencies:		
"A Hurricane Strikes Again" by Judson S. Bradley	Au	182
"When a Circus Burns" by Raymond A. Loring	Su	125
Employee Morale:		
"An Address" by Walter S. Gifford	Au	144
"Recreation Facilities for Bell System Women" by Raymond A. Steelman	Su	114
Employees—Changes and Appointments:		
Wilson, L. A., Elected vice-president of Company	Au	204
Employees—Retired:		
Banning, William: Retires	Au	203
Jewett, Frank Baldwin	Au	200
		208
Employees in Service—Awards:		
Anderson, Carl E. (Lieut.): Awarded Silver Star, and Croix de Guerre with Gold Star (Southern New England)	Au	164
Ankers, George M. (Lieut.): Won Legion of Merit (Pacific)	Au	162
Bailey, Rand S. (Major): Won Legion of Merit (A. T. & T.)	Au	162
Bedell, Robert L. (Lieut. j.g.): Awarded The Distinguished Flying Cross (C. & P., W. Va.)	Au	168
Bradley, Donald C. (Motor Machinist's Mate First Class): Won the Navy and Marine Corps Medal (Illinois)	Au	169
Coleman, A. R. E. (Comdr. R. C. N.): Received Distinguished Service Order (Canada)	Au	170
Ellis, Lewis N. (Capt.): Received Distinguished Service Cross, etc., awards (Southern Bell)	Au	159
"For Heroism, Gallantry, or Extraordinary Achievement" by Donald S. Bridgman	Au	157
Harris, Edward N., Jr. (Lieut. Col.): Awarded Silver Star (Long Lines)	Au	164
Heller, Russell K.: Awarded Silver Star	Au	164
Hoertel, Charles W.: Awarded Silver Star (Western Electric)	Au	164
Hunter, Robert (Lt.): Awarded Silver Star (Bell of Pa.)	Au	166
James, Walter G. (Lieut.): Won Legion of Merit (Pacific)	Au	163
Keith, Donald J. (Capt.): Awarded Distinguished Flying Cross (Northwestern)	Au	167
Kinney, Paul B. (Lieut. j.g.): Won Gold Star in lieu of a second Distinguished Flying Cross, (Ohio)	Au	168
Larden, Allan W. J. (Flight Sergeant): Received Conspicuous Gallantry Medal (Canada)	Au	171
Lowry, James P. (Lieut.): Awarded Silver Star (Bell of Pa.)	Au	165
Lynch, Benton (Tech. Sgt.): Awarded Silver Star (Indiana)	Au	164
McConville, Orman H. (Master Sergeant): Won Legion of Merit (New York)	Au	163
More than 55,000 in service	Su	92

Issue Page

O'Keefe, Arthur J. (Sgt.): Honorably discharged re-employed by Wisconsin ....Au 159
Silvey, William R. (Col.): Awarded Legion of Merit (New York) ....Au 163
Stillwagon, Arthur W. (First Lieut.): Won Bronze Star Medal (Michigan) ....Au 169
Thiesen, Emmet J. (Major): Awarded Distinguished Flying Cross (Michigan) ....Au 167
Vaughn, Belton K. (Corporal): Won Legion of Merit (Western Electric) ....Au 161

Employees in Service—Casualties:
Brewer, Luther G. (Lieut.): Killed in action (Southern Bell) Au 158
DeVinney, James F. (Capt.): Prisoner in Germany (New Jersey) ....Au 166
Gold Star, 308 on Bell System service flag ....Su 92
Hancock, Elzie J. (Pfc.): Killed in action (Southern Bell) ..Au 165
Hanks, Donald B. (Capt.): Missing in action (Mountain States) ....Au 169
Hendrix, Lloyd O. (Lieut.): Missing in action (Southwestern) ....Au 167
McLaughlin, Joseph D. (Lieut.): Killed in action (New England) ....Au 169
Sims, Weldon S. (First Lieut.): Killed in action (Southern Bell) ....Au 157

ERPI Classroom Films Inc.:
"Sound Movies for Sound Education" ....Su 129

F

Federal Communications Commission:
Adair, George P.: Appointed Chief Engineer of ....Sp 64
Craven, T. A. M.: Retired from ....Su 132
Jett, E. K.: Became member, Feb. 15 ....Sp 64

Fick, Knud: Biographical sketch ....Au 208
Fick, Knud: "The World's Telephones in Wartime" ....Au 205
Fleming, John Ambrose: Fleming valve ....Au 176
"FM Program Transmission: A Bell System Service" ....Wi 255
"For Heroism, Gallantry, or Extraordinary Achievement" by Donald S. Bridgman ....Au 157
Forbes, W. Cameron: Board of Directors, American Telephone and Telegraph ....Sp 4
"Frank Baldwin Jewett: An Appreciation" by Robert W. King ..Au 200
208

Frequency Modulation:
"FM Program Transmission: A Bell System Service" ....Wi 255

G

Gardner, G. Peabody: Board of Directors, American Telephone and Telegraph ....Sp 4

Issue Page

General Electric Company:
Western Electric's power apparatus manufacturing business sold to ....Wi 279
Gifford, Walter S.: Acceptance of Signal Corps "Certificate of Appreciation" ....Su 71
Gifford, Walter S.: "An Address" ....Au 146
204
Gifford, Walter S.: Became president of A. T. & T. in 1904 ....Wi 280
Gifford, Walter S.: Biographical sketch ....Au 134
Gifford, Walter S.: Board of Directors, American Telephone and Telegraph ....Sp 4
Gifford, Walter S.: Fortieth anniversary of service in the Bell System ....Su 132
Gifford, Walter S.: Post-war planning statement ....Su 92
Gifford, Walter S.: Speech before U. S. Independent Telephone Association, on rural telephone service ....Wi 215
Gifford, Walter S.: Statement on finance to stockholders ....Sp 63
Gray, Elisha: "Western Electric's First 75 Years: a Chronology" by Frank H. Lovette ....Wi 271
Graybar Electric Company:
Incorporated by Western Electric in 1925 ....Wi 280

H

Hanselman, John J.: Biographical sketch ....Wi 210
Hanselman, John J., and Osborne, Harold S.: "More and Better Telephone Service for Farmers" ....Wi 212
Haskell, William N. (Lt. General): Quote on Civilian Defense Service ....Sp 23
Held Applications:
Telephone equipment used in Pacific landing operation ....Wi 262
"We Don't Like to Say 'No'" by John W. Ord ....Su 103
Hilliard, Vance: Biographical sketch ....Sp 62
Hilliard, Vance: "Radio Telephones Guide the 'Blitz Buggies'" ..Sp 52
Hollingsworth, Burton A.: Biographical sketch ....Au 135
Hollingsworth, Burton A.: "I Knew Then I Was Home" ....Au 147
Hubbell, James W.: Died July 20, President of New York Telephone Co. ....Su 132
"Hurricane Strikes Again, A" by Judson S. Bradley ....Au 182

I

"I Knew Then I Was Home" by Burton A. Hollingsworth ....Au 147
Independent Telephone Companies: 12 cities in U. S. with 50,000 population served by ....Su 102
Ingles, Harry C. (Major General): Biographical sketch ....Su 66
Ingles, Harry C. (Major General): Presentation of "Certificate of Appreciation" award by ....Su 68

Issue Page

Ingles, Harry C. (Major General): "Telephones Are in the Fight on Every Battleground" ....Su 68
International Western Electric Company:
Organization and sale of ....Wi 280

J

Jett, E. K.: Became member of Federal Communications Commission ....Sp 64
Jewett, F. B.: First president of Bell Laboratories, succeeded in 1940 by Dr. Oliver E. Buckley ....Wi 281
Jewett, F. B.: "Frank Baldwin Jewett: An Appreciation" by Robert W. King ....Au 200
Jewett, F. B.: Fellowships ....Au 203

K

King, Robert W.: Biographical sketch ....Au 208
King, Robert W.: "Frank Baldwin Jewett: An Appreciation" ...Au 200

L

Labor Relations:
"An Address" by Walter S. Gifford ....Au 145
Lack, F. R.: Quote from FM Broadcasters, Inc., speech ....Sp 51
Lank, Herbert H.: Quote from address on Public Relations ....Sp 42
Long Lines Department:
National Security Award ....Sp 23
Loring, Raymond A.: Biographical sketch ....Su 67
Loring, Raymond A.: "When a Circus Burns" ....Su 125
Lovette, Frank H.: Biographical sketch ....Wi 211
Lovette, Frank H.: "Western Electric's First 75 Years: a Chronology" ....Wi 271

M

McHugh, Keith S.: Biographical sketch ....Sp 2
McHugh, Keith S., and Best, George L.: "The Bell System's Interest in Program Television" ....Sp 7
64
Mabbs, Ralph I.: Biographical sketch ....Wi 211
Mabbs, Ralph I.: "Providing Paths for Long Distance Calls" ..Wi 263
MacGill, Patricia: Essay on long distance calls ....Sp 31
Management:
"An Address" by Walter S. Gifford ....Au 139
Maps:
Bell System routes over which frequencies of 15,000 cycles or more are now transmitted for telephone purposes ..Wi 258
Chesapeake Bay, Application of carrier techniques to radio telephony ....Sp 32
Coaxial Cable Network in United States ....Sp 6
DBR Line ....Wi 242
Hurricane of September 1938 and 1944 ....Au 184

	Issue	Page
Military Telephone Service:		
"An Address" by Walter S. Gifford	Au	142
"Radio Telephones Guide the 'Blitz Buggies'" by Vance Hilliard	Sp	52
"A Review of Army and Navy Communication Facilities" by Myron F. Dull	Sp	13
"The Telephone Remakes Naval Warfare" by Fletcher Pratt	Sp	24
"Telephones Are in the Fight on Every Battleground" by Major General Harry C. Ingles	Su	68
Miller, Richard W.: Member of Bell System Communications, working with the Armed Forces	Sp	18
Mills, John: "Electronics—Today and Tomorrow" (Review by Harold S. Osborne)	Su	128
Mimeographs:		
Western Electric began manufacturing the Edison "Electric pen," predecessor of the mimeograph in 1876	Wi	274
Miner, Erle S.: "The Bell System's Safety Observation Plan"	Su	93
Miner, Erle S.: Biographical sketch	Su	66
"More and Better Telephone Service for Farmers" by John J. Hanselman and Harold S. Osborne	Wi	212
Morse, Samuel F. B.: Biography (A Century of Electrical Communication)	Sp	43

N

Nassau Smelting and Refining Company:		
Acquired by Western Electric in 1931	Wi	282
National Defense Research Committee:		
Bell Laboratories cooperation with	Wi	234
National Telephone Panel:		
Established	Wi	288
National War Labor Board:		
Established National Telephone Panel	Wi	288
New York Telephone Company:		
Hubbell, James W.: President of—Died July 20	Su	132
Northern Electric Company:		
Western Electric Company interest in	Wi	280

O

Ord, John W.: Biographical sketch	Su	66
Ord, John W.: "We Don't Like to Say 'No'"	Su	103
Osborne, Harold S.: Biographical sketch	Wi	210
Osborne, Harold S., and Hanselman, John J.: "More and Better Telephone Service for Farmers	Wi	212
Osborne, Harold S.: Review of "Electronics—Today and Tomorrow" by John Mills	Su	128
Osgood, Bruce E.: Member of Bell System Communications, working with the Armed Forces	Sp	18

Issue Page

P

Pacific Telephone and Telegraph Company:
"Building the West's New Telephone Route" .....Wi 241
Page, Arthur W.: Board of Directors, American Telephone and Telegraph .....Sp 4
Page, Arthur W.: Quote from book "The Bell Telephone System" on big business .....Sp 12
Parkinson, Thomas I.: Board of Directors, American Telephone and Telegraph .....Sp 4
Porter, Paul A.: Nominated a member of FCC .....Wi 288
Post-War Planning:
"The Bell System's Interest in Program Television" .....Sp 7
64
"FM Program Transmission: A Bell System Service" .....Wi 255
Gifford, Walter S.: Statement on .....Su 92
"More and Better Telephone Service for Farmers" by John J. Hanselman and Harold S. Osborne .....Wi 212
Pratt, Fletcher: Biographical sketch .....Sp 3
Pratt, Fletcher: "The Telephone Remakes Naval Warfare" .....Sp 24
Privacy of Service:
"An Address" by Walter S. Gifford .....Au 141
"Providing Paths for Long Distance Calls" by Ralph I. Mabbs ..Wi 263
Public Relations:
Quote from address by Herbert H. Lank .....Sp 42
"We Don't Like to Say 'No'" by John W. Ord .....Su 103

R

Radar:
"Bell Laboratories in the War" by Oliver E. Buckley .....Wi 234
Radio:
"Bell Laboratories in the War" by Oliver E. Buckley. "Developments in Radio" .....Wi 232
"Radio Telephones Guide the 'Blitz Buggies'" by Vance Hilliard .....Sp 52
Radio Telephony:
"An Address" by Walter S. Gifford .....Au 145
"A Bridge for Speech Across Chesapeake Bay" by Austin Bailey .....Sp 32
The "D-Day" announcement of the Allied invasion of the coast of France .....Su 132
FCC authorization to build experimental radio stations in New York and Boston for repeatered radio telephony ..Su 132
"More and Better Telephone Service for Farmers" by John J. Hanselman and Harold S. Osborne .....Wi 222
New York-Boston radio relay system .....Wi 261
"Radio Telephones Guide the 'Blitz Buggies'" by Vance Hilliard .....Sp 52
Restrictions between U. S., Bahamas, Jamaica, and Trinidad lifted .....Sp 64

	Issue	Page
Service officially opened between U. S. and Trinidad, B. W. I.	Sp	64
"The Telephone Remakes Naval Warfare" by Fletcher Pratt	Sp	24
"Telephones Are in the Fight on Every Battleground" by Major General Harry C. Ingles	Su	68
Wave lengths, shorter, Use of	Sp	11
Rates—Telephone:		
Night message toll became effective at 6 P.M., instead of 7 P.M., reduction in overtime rates and most teletypewriter	Sp	64
Reduction of rates for service to Hawaii, Bahamas, and Jamaica	Wi	288
Reductions on calls to Costa Rica, Gutemala, Honduras, Nicaragua, Panama, Curacao, and Surinam	Au	204
Telephone rates to Argentina, Brazil, Chile, Peru, Colombia, Puerto Rico, and Haiti, to be lowered, beginning August 1	Su	132
Rates—Telephone—Radio:		
Reduction on calls to Hawaii, Jamaica, and the Bahama Islands, effective Nov. 1	Au	204
Rates—Telephone—Rural:		
Changes during last 15 years	Wi	215
Rates—Teletypewriter:		
Reduction in overtime rates	Sp	64
"Recreation Facilities for Bell System Women" by Raymond A. Steelman	Su	114
Research:		
"An Address" by Walter S. Gifford	Au	146
"Bell Laboratories in the War" by Oliver E. Buckley	Wi	227
Jewett, Frank B., Fellowships	Au	202
"The Role of Electronics in Telephone Service" by Austin Bailey	Au	172
Restoration of Service:		
"A Hurricane Strikes Again" by Judson S. Bradley	Au	182
"Review of Army and Navy Communication Facilities, A" by Myron F. Dull	Sp	13
"Role of Electronics in Telephone Service, The" by Austin Bailey	Au	172
Root, Elihu, Jr.: Board of Directors, American Telephone and Telegraph	Sp	4
Rural Electrification Administration:		
Cooperation in application of power-line carrier system for telephone service	Wi	220
Rural Telephone Service:		
"An Address" by Walter S. Gifford	Au	141
Farms with telephones as related to value of the farms' products	Wi	216
"More and Better Telephone Service for Farmers" by John J. Hanselman and Harold S. Osborne	Wi	212
Rural and urban telephones; chart showing the substantial growth of telephones in rural areas	Wi	214

Issue Page

S

Safety:
"The Bell System's Safety Observation Plan" by Erle S. Miner ....Su 93
Salt, Albert L.: President of Graybar Electric Co. ....Wi 280
Salvage:
Salvage of equipment left behind by Germans extremely difficult ....Su 71
Scribner, Charles E.: "Western Electric's First 75 Years: a Chronology" by Frank H. Lovette ....Wi 271
Service-Stations:
"More and Better Telephone Service for Farmers" by John J. Hanselman and Harold S. Osborne ....Wi 212
Shawk, George: Biographical sketch ....Wi 273
Skillett, A. M. (Dr.): Produced secondary electrons ....Au 180
Slugs:
Bill makes the manufacture or sale of slugs for fraudulent purposes a felony ....Sp 64
Smith, Richard C.: Biographical sketch ....Wi 211
Smith, Richard C.: "Building the West's New Telephone Route" Wi 241
Smith, Tom K.: Board of Directors, American Telephone and Telegraph ....Sp 4
Smoot, William S.: "Western Electric's First 75 Years: a Chronology" by Frank H. Lovette ....Wi 271
"Sound Movies for Sound Education" by William Benton ....Su 129
Spencer, Theodore: Plan for combining purchasing power of Western Electric and Bell System ....Wi 278
Stager, Anson: "Western Electric's First 75 Years: a Chronology" by Frank H. Lovette ....Wi 271
Steelman, Raymond A.: Biographical sketch ....Su 67
Steelman, Raymond A.: "Recreation Facilities for Bell System Women" ....Au 114
Stockholders:
"An Address" by Walter S. Gifford ....Au 140
Annual meeting April 19, 1944 ....Sp 5
64
Gifford, Walter S.: Statement on finance to ....Sp 63
Gifford, Walter S.: Statement on post-war planning to ....Su 92
Quarterly dividend of $2.25 a share on capital stock declared Su 132
Stoll, Clarence G.: Elected president of Western Electric, January 1, 1940 ....Wi 283
Surveys—Rural:
Results of rural surveys ....Wi 225

T

Taylor, Myron C.: Board of Directors, American Telephone and Telegraph ....Sp 4
Telegraph—History:
"An Address" by Walter S. Gifford ....Au 137

	Issue	Page
"A Century of Electrical Communication" by Robertson T. Barrett	Sp	43
Telephone Centers:		
"An Address" by Walter S. Gifford	Au	143
"I Knew Then I Was Home" by Burton A. Hollingsworth	Au	147
Telephone Industry:		
"An Address" by Walter S. Gifford	Au	137
		204
"Telephone Remakes Naval Warfare, The" by Fletcher Pratt	Sp	24
"Telephones Are in the Fight on Every Battleground" by Harry C. Ingles	Su	68
Telephones—History:		
"A Century of Electrical Communication" by Robertson T. Barrett	Sp	43
Telephones—Statistics:		
Telephone statistics of the world	Au	206
"The World's Telephones in War-time" by Knud Fick	Au	205
Teletype Corporation:		
Purchased by Western Electric in 1930	Wi	282
Teletypewriters:		
Bell System exchange service inaugurated in 1931	Wi	282
"A Review of Army and Navy Communication Facilities" by Myron F. Dull	Sp	13
Television:		
"The Bell System's Interest in Program Television"	Sp	7
		64
Coaxial Cable Routes, Tentative	Sp	9
Thayer, Harry B.: "Western Electric's First 75 Years: a Chronology" by Frank H. Lovette	Wi	271
Thomson, J. J.: Contribution to electronics	Au	177
Toll Calls:		
Effect of group size on number of circuits required	Wi	268
Essay on long distance calls, by Patricia MacGill	Sp	31
"Providing Paths for Long Distance Calls" by Ralph I. Mabbs	Wi	263
Toll Control:		
"An Address" by Walter S. Gifford	Au	143
Training:		
Army teletypewriter operators	Sp	23
Service representatives	Su	107
Signal Corps technicians to repair and maintain the vehicular radio equipment	Sp	62
"Sound Movies for Sound Education"	Su	129
Typewriters:		
Western Electric co-designed with Remington Arms the first commercial typewriter	Wi	274

Issue Page

U

United States Independent Telephone Association:
"An Address" by Walter S. Gifford ..... Au 137
204
Gifford, Walter S.: Speech before, on rural service ..... Wi 215
12 cities in U. S. with 50,000 population served by independent telephone companies ..... Su 102

V

Vail, Theodore N.: Arranged to buy a minority interest in Western Electric for Bell organization ..... Wi 276
Vail, Theodore N.: Reorganization of A. T. & T. ..... Wi 278

W

War Bonds:
Bell System employees purchase of ..... Sp 63
War Production Board:
Authorized the manufacture of 800,000 telephone sets for civilian use ..... Su 132
Customers' Appeals to ..... Su 108
Orders ..... Sp 64
Su 108
Au 132
Watson, Thomas A. ..... Sp 50
"We Don't Like to Say 'No'" by John W. Ord ..... Su 103
Welldon, Samuel A.: Board of Directors, American Telephone and Telegraph ..... Sp 4
Welles, Francis R.: "Western Electric's First 75 Years: a Chronology" by Frank H. Lovette ..... Wi 271
Western Electric Company:
FM vehicular radio equipment made for Army ..... Sp 53
Government sales in 1944 ..... Wi 286
"Hurricane Strikes Again, A" by Judson S. Bradley ..... Au 182
Lack, F. R.: Quote from FM Broadcasters, Inc., speech .... Sp 51
Machinery and equipment from Hawthorne and Point Breeze plants moved to St. Paul, Minn. ..... Su 132
Materials furnished by, in hurricanes of 1944 and 1938 ..... Au 193
"Western Electric's First 75 Years: A Chronology" by Frank H. Lovette ..... Wi 271
Western Union Telegraph Company:
Formation of ..... Wi 272
"When a Circus Burns" by Raymond A. Loring ..... Su 125
Willenbucher, Franz O. (Commander U. S. N.): Appointed Traffic Coordinator BWC ..... Sp 64
Williams, S. Clay: Board of Directors, American Telephone and Telegraph ..... Sp 4
Wilson, L. A.: Elected Vice-President ..... Au 204
Woodward, Marion H.: Appointed Assistant Traffic Coordinator BWC ..... Sp 64

	Issue	Page
World War I:		
"Western Electric's First 75 Years: a Chronology" by Frank H. Lovette	Wi	279
World War II:		
"An Address" by Walter S. Gifford	Au	137
		204
"Bell Laboratories in the War" by Oliver E. Buckley	Wi	227
"Building the West's New Telephone Route" by Richard C. Smith	Wi	241
"Communications and Air Power" by H. H. Arnold (General)	Su	91
"For Heroism, Gallantry, or Extraordinary Achievement" by Donald S. Bridgman	Au	157
"Radio Telephones Guide the 'Blitz Buggies'" by Vance Hilliard	Sp	52
"A Review of Army and Navy Communication Facilities" by Myron F. Dull	Sp	13
Telephone equipment used in Pacific landing operation	Wi	262
"The Telephone Remakes Naval Warfare" by Fletcher Pratt	Sp	24
"Telephones Are in the Fight on Every Battleground" by Maj. Gen. Harry C. Ingles	Su	68
"Western Electric's First 75 Years: a Chronology" by Frank H. Lovette	Wi	283
"The World's Telephones in War-time" by Knud Fick	Au	205
"World's Telephones in War-time, The" by Knud Fick	Au	205

lume XXIII ~ Number One Spring 1944

Bell Telephone MAGAZINE

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Bell System's Interest in Program Television • KEITH S. MCHUGH and GEORGE L. BEST

A Review of Army and Navy Communication Facilities • MYRON F. DULL

The Telephone Remakes Naval Warfare • FLETCHER PRATT

A Bridge for Speech across Chesapeake Bay • AUSTIN BAILEY

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merican Telephone & Telegraph Company · New York

Bell Telephone *Magazine*

Spring 1944

The Directors of the American Telephone and Telegraph Company, 4–5

The Bell System's Interest in Program Television, *Keith S. McHugh* and *George L. Best*, 7

A Review of Army and Navy Communication Facilities, *Myron F. Dull*, 13

The Telephone Remakes Naval Warfare, *Fletcher Pratt*, 24

A Bridge for Speech across Chesapeake Bay, *Austin Bailey*, 33

A Century of Electrical Communication, *Robertson T. Barrett*, 43

Radio Telephones Guide the "Blitz Buggies," *Vance Hilliard*, 52

Aid to Victory, 63

For the Record, 64

"The ideal and aim of the American Telephone and Telegraph Company and its Associated Companies is a telephone service for the nation, free, so far as humanly possible, from imperfections, errors, or delays, and enabling anyone anywhere to pick up a telephone and talk to anyone else anywhere else, clearly, quickly and at a reasonable cost."

A Medium of Suggestion & a Record of Progress

Published for the supervisory forces of the Bell System by the Information Department of American Telephone and Telegraph Company, *195 Broadway, New York, N. Y.*

Who's Who & What's What *in This Issue*

EMPLOYED as a clerk by the A. T. & T. Co. in 1919, elected a vice president of the same company in 1938: that is KEITH MCHUGH's up-the-ladder record. Chronologically a straight ascent, geographically it included stop-overs in Washington, D. C., with the Chesapeake and Potomac Telephone Company, and in Albany, Brooklyn, and Manhattan with the New York Telephone Company. *En route*, Mr. McHugh held positions as general commercial engineer, general commercial manager, and vice president with those companies; and was commercial engineer and assistant vice president with A. T. & T. before reaching his present post. In it he has to—and does—take always the broad view. His article shows how that can be the long view too. "War Activities of the Bell Telephone System," in the issue for November, 1942, was his previous contribution to this MAGAZINE.

THE CONSERVATIVE STREAK in GEORGE BEST's make-up is no surprise to those who know that he was born, "raised up," and educated in Vermont. Once away from that green-hilled state, he joined the New York Telephone Company in 1922, and held successive positions in the commercial department there for the next 15 years. In 1937 he was transferred to the commercial division of A. T. & T., and was rate engineer and commercial engineer before becoming, in 1942, an assistant vice president on Mr. McHugh's staff.

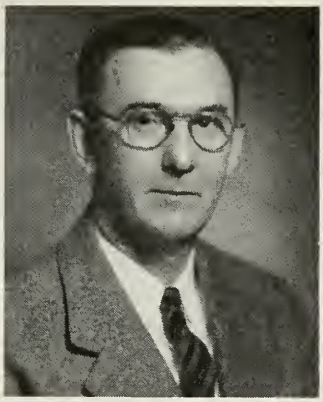
METHODS OF military communication have changed so radically since the last World War that the relation between MYRON DULL's service with the Signal Corps in 1918–19 and his present assignment is probably, as publishers say, "purely coincidental." His 27 years with the Bell System have brought him plenty of qualifications, in any event, to carry on the work which he describes. They include experience as district manager at Newcastle and general directory manager and general sales manager for the western area of the Bell Telephone Company of Pennsylvania; and since 1929 with A. T. & T. Company's Depart-

KEITH S. MCHUGH

GEORGE L. BEST

MYRON F. DULL

FLETCHER PRATT



AUSTIN BAILEY

ROBERTSON T. BARRETT

ment of Operation and Engineering in charge of groups concerned with customer servicing and with toll and teletypewriter development. Washington has been his base for the past year and a half, so by now he can really find his way through the mazes of the Pentagon, where he has his office.

FOR EXPERT OPINION about how radio telephony is affecting the strategy and tactics of our battle fleets, the editors turned to FLETCHER PRATT, whose article makes encouraging reading for anyone (except our enemies) and gratifying reading for all those who have had anything to do with the development or manufacture or application of that kind of equipment. Mr. Pratt is well known as a student of and writer on naval subjects. He does a syndicated daily newspaper column on current events and military affairs; a series of his articles has been appearing in *Harper's Magazine;* and he is the author of a number of books, including "The Navy: A History," "Secret and Urgent: The Story of Codes and Ciphers," "The Navy Has Wings," and others. Membership in the U. S. Naval Institute attests to the competence of his judgment on matters nautical.

THE AVERAGE LAYMAN should find the application of carrier techniques to radio transmission less of a mystery after reading AUSTIN BAILEY'S explanation of how a dozen voices can be carried at one time across the mouth of Chesapeake Bay. Before joining the Bell System in 1922 he had acquired both A.B. and Ph.D. degrees, and experience in the Signal Corps in the last World War, in private industry, and as a college professor. Since then he has been a member of the Departments of Development and Research and Operation and Engineering of the A. T. & T. Co., and of the Bell Telephone Laboratories, and spent a year in England and Scotland in connection with establishing the first commercial transatlantic radio telephone circuit. He is regularly concerned with the technical aspects of numerous radio projects. He has contributed several articles to this MAGAZINE, the most recent, in the issue for November, 1942, being "Bridging Breaks in Wire Circuits by Radio Telephone."

THE POST of Historical Librarian of the A. T. & T. Co. provides background information for ROBERTSON T. BARRETT'S "A Century of Electrical Communication." Practice of the law and of journalism successively engaged him before he joined the Information Department in 1921. As a member of the departmental staff, he has contributed more articles to this publication and its predecessor, the *Bell Telephone Quarterly,* than any other person; most

(*Continued on page 62*)

The Board of Directors of the American Telephone and Telegraph Company

At the annual meeting of stockholders of the American Telephone and Telegraph Company held on April 19, the directors then in office were re-elected. The picture on the opposite page, taken at the March meeting of the Board, shows all members in attendance. Beginning with Mr. Gifford, at the head of the table in the foreground, and reading clock-wise, they are:

Walter S. Gifford. President, American Telephone and Telegraph Company.

John W. Davis. Attorney; Member of Firm of Davis Polk Wardwell Sunderland & Kiendl, New York, N. Y.

Charles P. Cooper. Vice President, American Telephone and Telegraph Company.

Samuel A. Welldon. Vice President, The First National Bank of the City of New York.

Arthur W. Page. Vice President, American Telephone and Telegraph Company.

W. Cameron Forbes. Partner, J. M. Forbes and Company, Merchants, Boston, Mass.

G. Peabody Gardner. Trustee.

Tom K. Smith. President, The Boatmen's National Bank of St. Louis.

Thomas I. Parkinson. President, The Equitable Life Assurance Society of the United States.

Isaiah Bowman. President, Johns Hopkins University.

Lewis H. Brown. President, Johns-Manville Corporation.

David A. Crawford. President, The Pullman Company.

Elihu Root, Jr. Attorney; Member of Firm of Root, Clark, Buckner & Ballantine, New York, N. Y.

S. Clay Williams. Chairman of the Board, R. J. Reynolds Tobacco Company.

James F. Bell. Chairman of the Board, General Mills, Inc.

Winthrop W. Aldrich. Chairman of the Board, The Chase National Bank of the City of New York.

Myron C. Taylor. Attorney.

Charles Francis Adams. Chairman of the Board, State Street Trust Company of Boston.

BELL SYSTEM COAXIAL ROUTES

The Expansion of the Coaxial Cable Network to Several Thousand Route Miles by 1950 Holds Great Possibilities for the Transmission of Television Programs

The Bell System's Interest in Program Television

Keith S. McHugh and George L. Best

THE POSSIBILITIES OF TELEVISION in the field of entertainment and education have captured the imagination of a great many people, both in this country and in other countries. While its development is temporarily retarded by the war, there is every indication that a new industry, perhaps rivaling in scope the present sound broadcasting industry, is in the making.

There are now broadcasting stations in New York, Philadelphia, Schenectady, Chicago, and Hollywood presenting regularly-scheduled television programs for a few hours each week. The owners of these stations are planning to extend and improve their programs as rapidly as they can. Plans are also being made to establish new television broadcasting stations, following the war, in many other cities throughout the country.

Manufacturers of radio receiving sets are engaged in developing ways of making television receivers which can be sold at prices within the range of the average person. Sales promotion programs are being prepared to distribute these sets as rapidly as they can be put on the market.

Motion picture and theater people are considering the possibilities of large screen television in theaters to bring news events of especial interest to their audiences as they happen. They are also studying its possibilities as a means of offering various forms of entertainment, including prize fights, football games, track meets, etc. Schools and colleges are beginning to think about television as an aid to education.

While a great deal remains to be done, technically and otherwise, before television comes into common use, the present and proposed widespread activity in this field raises the question as to what part the Bell System is playing in the development of this new industry.

The Need for Network Transmission Facilities

Up to now, television programs have been confined largely to local events of interest, local studio programs, and sound films. While considerable use may continue to be made of this type of program material, television will not reach its ultimate usefulness until it is possible to bring programs from distant points to a number of cities at the same time. It is in the provision of network facilities by which broadcasting stations and others can be connected that we believe the Bell System's primary part in program television will be played, just as it has been in sound broadcasting. That this rôle is one of great importance to the development of television is evident.

Television transmission consists of sending from the point of origin of the program to the receiving apparatus at the distant point a complete description of about thirty different visual images per second. This is done in effect by dividing each image into 200,000 or more different parts and sending a signal to the distant point indicating the density or degree of brightness of each part, together with its position in relation to other parts of the image. The receiving apparatus then translates these signals into a motion picture. The transmission of television, therefore, requires facilities capable of transmitting six million or more different signals per second.

The types of circuit facilities required to transmit television signals in the required quantity and speed are closely related to those needed for the transmission of large numbers of telephone or telegraph messages simultaneously. Coaxial cable is designed to carry large numbers of telephone conversations simultaneously over a single pair of conductors and, if properly equipped for such use, is also suitable for transmitting television.

Coaxial cable, in the form now being used by the Bell System, is the result of years of research and development work in the Bell Telephone Laboratories. The first commercial trial of coaxial cable for telephone use in this country was made between New York and Philadelphia in 1936. Its use for transmitting visual images for television broadcasts was first demonstrated in 1937.

Since that time, coaxial cable has been installed between Minneapolis and Stevens Point, Wisconsin, and between Philadelphia and Washington. A coaxial cable route between Atlanta and Jacksonville is now under construction.

As a part of its program to meet expected increasing demands for long distance telephone service, the Bell System is planning to construct within the next few years a large amount of additional coaxial cable. The extent of this construction, where and when it will be undertaken, will depend upon the requirements of our armed forces, general business conditions, the volume and distribution of long

distance messages, the availability of necessary manufactured cable and equipment, and other factors. Tentatively, however, Bell System plans call for between six and seven thousand route miles of coaxial cable in the next five or six years, representing an investment of something in the neighborhood of $100,000,000.

The adjoining column and the map on page 6 show the routes over which coaxial or equivalent facilities are being planned in the present program. The routes indicated are those where the need for additional telephone channels in substantial quantity is expected to be the most urgent and where the provision of coaxial cable appears to be the most desirable method of meeting this need. When coaxial facilities are being constructed for telephone purposes, it would be possible to provide additional conductors for television, and it is planned to do so if then it appears likely that there will be a demand for such facilities sufficient to justify the large additional investment.

REQUESTS for television facilities over routes where coaxial cable is not being planned during this period for telephone purposes would be considered on their merits. The question of when such facilities could be provided would depend upon conditions in the individual case and its relation to the total program. It is, of course, in the interest of economy to provide for television requirements in connection with providing cable for telephone purposes to the extent possible.

The equipment now developed for use with coaxial cable will give a one-

Tentative Program of Coaxial Cable Routes

Bell System

APPROXIMATE DATES at which television transmission facilities might be made available, if demand justifies their provision and manufactured cable and equipment can be secured, in accordance with present tentative program for extension of principal coaxial cable or equivalent routes for telephone purposes:

1945

New York-Washington.

1946

New York-Boston.
Washington-Charlotte.
Chicago-Terre Haute-St. Louis.
Los Angeles-Phoenix.

1947

Chicago-Toledo-Cleveland-Buffalo.
Southern Transcontinental Route (a large part) will include Charlotte-Columbia - Atlanta - Birmingham - Jackson - Dallas - El Paso - Tucson-Phoenix.

1948–1950

Southern Transcontinental (complete).
Washington-Pittsburgh-Cleveland.
St. Louis-Memphis-New Orleans.
Kansas City-Omaha.
Des Moines-Minneapolis.
Atlanta-Jacksonville-Miami.
Los Angeles-San Francisco.

THE ROUTES INDICATED are subject to review prior to the time construction would be started.

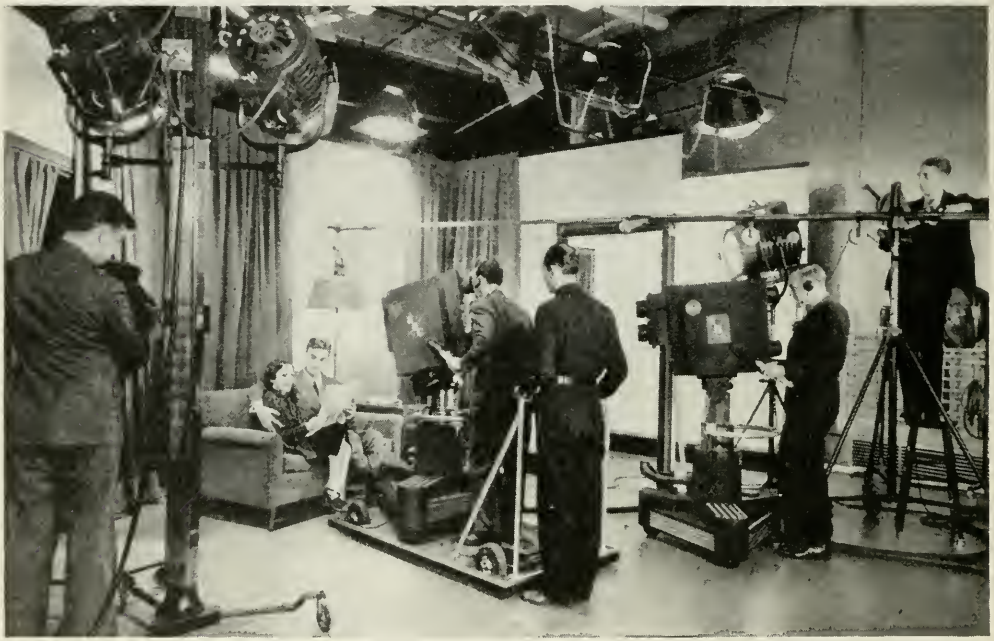
THE LIST does not include additional sections which might be advanced into this period should important television requirements arise which would warrant routes or sections being installed well ahead of telephone requirements.

way television channel transmitting an effective band 2.7 megacycles (2,700,000 cycles) in width by the exclusive use of a single coaxial unit or pipe. A rough idea of the capacity of such a frequency band width to carry television signals can be had from the fact that 480 telephone circuits can be provided over a single pair of coaxials with present amplifying equipment. The trials which have been made over existing coaxial cable routes have indicated that such a channel will permit the transmission of very satisfactory television pictures.

Future technical developments will increase the band width to 4.0 megacycles, which will, of course, permit a still better picture. Facilities for still wider band widths, should they be required by the industry, would require further development work.

Future developments are also expected to provide for simultaneous use of a single coaxial unit to transmit a television channel and a large number of telephone channels. Consequently, the ultimate number of television facilities which could be provided over these cables will be considerably greater than the initial number. These ultimate possibilities must, of course, be taken into account in determining the number of coaxial units to be installed in the cables.

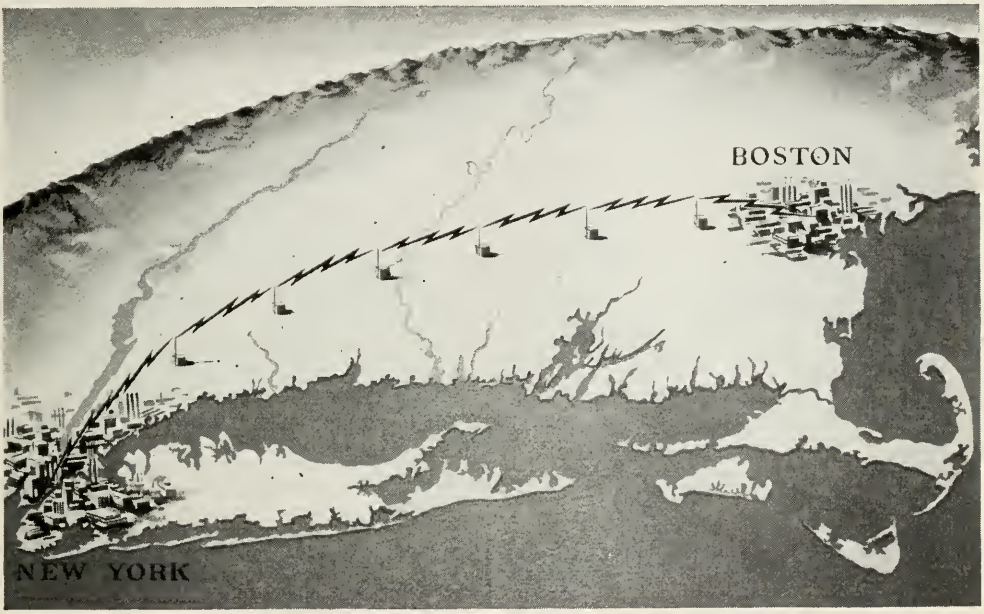
In addition to its program for the



So SIMPLE an indoor set and action as that shown here requires a good deal of equipment for "telecasting"

construction of coaxial cable, the Bell System is planning a trial between New York and Boston of a radio relay system which will be suitable for the transmission of television as well as telephone messages. This new system is of a type which was under development by the Bell Laboratories prior to the war, and applies to communication by radio many of the techniques which have played an important part in the development of long distance telephone circuits. Directed radio beams at ultra high frequencies will operate simultaneously in both directions and these will be relayed at stations spaced at an average of about thirty miles throughout the route.

This project represents another step in the march of radio telephony to utilize shorter and shorter wave lengths. Overseas commercial radio telephony to England was initiated by the Bell System in 1927 using very long waves. Soon afterward short waves were developed for transoceanic telephony. Using still shorter waves, only two or three meters long, which do not travel much beyond the horizon, radio telephone service was established just before the war across Chesapeake and Massachusetts Bays. The new project proposes to use micro-waves which are shorter than have heretofore been used for commercial telephony.



An experimental radio relay system. This sketch shows how New York and Boston may be linked by telephone facilities which supplement long distance wire lines and also provide for television transmission

The principal purpose of the trial

is to determine, first by experiment and then by practical operation in commercial service, the relative advantages and disadvantages of radio relay in transmission of long distance messages and television programs compared with transmission by other means. Relative costs represent only one of the factors to be determined; others include the relative quality of transmission, flexibility under actual operating conditions, and dependability. It is hoped that the new radio system will prove to be valuable as an additional means of meeting both telephone and television communications requirements.

THE PLANS which have been discussed for the construction of coaxial cable or equivalent facilities are necessarily very tentative. A great deal of work is, of course, required on the part of the television industry before we can know and plan accurately for its future needs for network facilities. Depending upon the speed of growth of the industry, therefore, it may be necessary for broadcasters and other users to do some sharing of television network facilities for a few years. This is one of the many problems which must be worked out during the early stages of development of the new television industry.

Where television facilities are required within a single exchange or between near-by exchanges, it is feasible to provide them within reasonable limits by means of ordinary telephone circuits with suitable equipment, or to provide them by circuits especially designed for the purpose.

The Bell System is doing everything it can practically to coöperate in the development and extension of television, just as it has coöperated in the distribution of sound programs. To that end, it is keeping closely in touch with the plans and requirements of the television industry, as they develop, and arranging its plans accordingly. By doing so, it hopes not only to make its own plans wisely but to be of maximum service to the television industry.

NEITHER BOARDS OF DIRECTORS nor the conduct of business has been perfect in the past, nor are they likely to be in the future. But the large publicly owned enterprises, controlled by boards of directors and managed largely by men who came up in the business they managed, performed rather better than most business during the depression. Financially, they survived better than small business or farmers or most other activities. They did as well or better than any other group in providing jobs, raising money and paying taxes. They maintained wages better than other groups. The breakdowns in character in big business from the nature of the case are more spectacular than those in little business, but the actual proportion is probably smaller. And it ought to be, for the public has a right to expect greater responsibility, and greater wisdom in the moralities in big enterprise than in small ones.

From "The Bell Telephone System," by Arthur W. Page, Vice President, A. T. & T. Co. Harper & Brothers, publishers, 1941.

A Bell System Committee Has Been Working with the Armed Forces to Bring About Greater Efficiencies in Their Telephone and Teletypwriter Communications

A Review of Army and Navy Communication Facilities

Myron F. Dull

For years the Bell System's customers, large and small, industrial, mercantile, and governmental, have been accustomed to look to their telephone companies for assistance with their communication problems. All of the System operating companies have servicing organizations for this purpose, and never before has this work been so important as now, in the midst of war.*

The Associated Companies and the Long Lines Department have been giving day-to-day counsel to the Army and Navy at their individual establishments right along. More recently, both Services have also turned to the System for assistance on a nation-wide basis in coöperation with their own communication specialists.

The Army provides a good illustration of the communication problems with which both Services have been faced. Its normal peace-time military personnel numbered about 200,000 men. True, administering the activities of so many people, especially when they comprise many small units scattered from coast to coast, requires a good deal of communication. Nevertheless, the Army found that, with private branch exchange switchboards (PBX's) in its military establishments, with the use of long distance telephone service, the mails, and commercial telegrams, and with the operation of its own radiotelegraph channels between Washington and the nine Service Commands (or Corps Areas, as they were formerly called) into which the continental United States is divided, its communication needs could be served very comfortably.

Then came the outbreak of war in Europe. Germany invaded Belgium and the Netherlands, sweeping all opposition before it. Dunkirk followed. France fell. Britain was besieged

* See "Telephone Service for War Industries," Magazine, June, 1943.

from the air and its invasion seemed imminent. For us in the United States it was a time of deep apprehension. And so, we looked to our defenses. The Neutrality Law was rescinded. The 50 destroyers were exchanged for bases. We adopted Lend Lease, became the Arsenal of Democracy. Congress passed Selective Service.

Communications Also Grew

ALL THE WHILE, of course, the Army's and Navy's communications were feeling the impact of these historic developments. With the coming of the draft, the building of camps and cantonments, the construction of powder plants and arsenals, and the expansion of war industries, communications leaped skyward.

Then came Pearl Harbor. Soon the Army numbered millions. Soon there were hundreds of military establishments. Soon there were thousands of industries making war materials, shipyards building cargo and war vessels. Soon also there was the submarine menace and the threat of air attack. All these matters had to be planned for and administered and coördinated to a central purpose, with haste, through communications.

Obviously, the radio channels between the Service Commands were insufficient to meet these stupendous and ever-mounting needs. The use of long distance telephone service by the Armed Forces grew apace. Even greater, relatively, was the growth in teletypewriter service. Use of the teletypewriter was quite natural, because it provides such an efficient means for handling swiftly the written communication which is vital in so much of military administration.

For purposes of illustration, let us narrow the focus, so to speak, and single out just one military establishment—almost any one would do. It has been decided, let us say, to build an Army camp. First come the Engineers, to survey and supervise construction; they need communication with Washington and also with their Service Command headquarters. Telephones and teletypewriters are installed for them. As construction proceeds, soldiers move in, and the Quartermaster Corps, the Ordnance units, Medical Corps, and other branches now have communication needs—with Washington and other places. They too have teletypewriter service. All this, it should be pointed out, is in addition to the PBX service which has by this time been installed to serve the entire establishment's telephone needs.

IT WAS through a process such as this, in sum, with so many divisions or branches adding facilities to meet their own immediate and individual requirements, that hundreds—even thousands—of separate communication services were established all over the country. It could hardly have been otherwise. Speed, it must be emphasized, was of the essence. There was no time in those early, urgent days of the war for full consideration of how to secure maximum communications efficiency for the Army as a whole. There was no time for lengthy consideration of whether some integration or coördination of wire facilities would be more efficient, or whether one type of grouping would be more efficient than some other. Central control, supervision of these thousands of

widely scattered installations, in those critical days was next to impossible.

Meanwhile, shortages began to develop in the very materials which are most essential in communication equipment: copper, rubber, aluminum, steel, etc. Demands for communication equipment from the Army contingents already overseas were beginning to make themselves felt. Its conservation became more than merely desirable; it became vital to the success of the war effort itself.

Recognizing this, as well as the duplications and potential inefficiencies in the kind of expansion which had taken place, the Signal Corps early took action. To understand its scope, it must be realized that not all military communications fall into the same category. While all are important, there are varying degrees of speed and security and other requirements which materially affect the type of service to be used. Generally speaking, fast written military communications fall into one of the following classifications:

U. S. ARMY SIGNAL CORPS PHOTO

WACS receiving Army messages on page-type teletypewriters in a War Department Signal Center. Thousands of messages are sent and received daily in these Centers over teletypewriter facilities

Tactical operations, requiring practically instantaneous contact

and usually calling for immediate acknowledgment or back-and-forth "conversation."

Other operations, where somewhat slower speeds are satisfactory but which may call for back-and-forth "conversation" in some cases.

General administrative and other functions with varying speed requirements and little need for immediate back-and-forth "conversation."

Teletypewriter Network

THE SIGNAL CORPS believed that if, for example, the many individual teletypewriter services devoted largely to the administrative type of message could be welded into an over-all and coherent system, greater efficiencies and economies, better service, and savings in critical materials would accrue. The Signal Corps thereupon evolved a plan for coördinating these communications, called the Army Command and Administrative Network. (There are also in existence several large Army communications networks serving special requirements, especially in the Air Force.)

In order to visualize the Administrative Network, a few basic facts about teletypewriter service must be understood. Bell System people are, of course, familiar with the teletypewriter itself: that amazing machine which, by transmitting certain combinations of electrical impulses, reproduces typewriting instantaneously on a similar machine at a distance. What may not be known to everybody, however, is that there are two forms of this service. In one, called private-line or leased-line service, teletypewriter machines are connected with each other by direct circuits reserved exclusively for their own use. In the other, called teletypewriter exchange service (commonly abbreviated to TWX), each machine is connected with a teletypewriter central office, which can connect one machine with another in much the same way that a local manual central office or toll office switches telephone calls. Indeed, a TWX subscriber has a teletypewriter number, just as a telephone subscriber has a telephone number.

The typed message may appear either on paper tape, which is about a half-inch wide, or on a full-width page, depending on the type of machines used. Moreover, there is apparatus which can cause the teletypewriter message to come out in the form of perforations in the tape; and it is possible also to have the typing itself superposed upon the perforations so that the message may easily be read. This perforated tape can then be fed into an automatic transmitter, whereupon the perforations produce electrical impulses which transmit the original message to still another machine, either in tape or page form or again on perforated tape, thus enabling this process to be repeated. The Signal Corps plan for an Army Command and Administrative Network takes advantage of this latter facility.

IN BRIEF, this plan provides that so-called Signal Centers be set up in various cities throughout the United States, connected with each other by a network of private line teletypewriter circuits. Military establishments or units within the area covered by each Center would have

access to it by private line teletypewriter, TWX, or commercial telegraph —depending on the character and volume of the traffic.

To visualize the process, assume for a moment that one Army unit wants to get a message to another and that both are equipped with teletypewriters. The sending point teletypes the message to its Signal Center. There the message comes off the receiving machine in the form of perforated tape plus the typing itself. An attendant examines the tape, noting from the address on the message that its destination is reached via another Signal Center in a distant city. This tape is simply inserted into the automatic transmitter connected by a private-line circuit with that Center, and in a few moments the message appears at the latter point, again on perforated tape. The attendant at that point, noting its destination, inserts it in a transmitter connected, either by direct circuit or TWX, with the teletypewriter machine at the terminating point.

U. S. ARMY SIGNAL CORPS PHOTO

WACS receiving and sending Army messages with automatic equipment in a War Department Signal Center. This photograph illustrates the relay method of handling teletypewriter messages by means of perforated tape

Those familiar with teletypewriter operation will quickly recognize that

this service is not as fast as either private line teletypewriter service or TWX. The point is that, to care for administrative communications of the type being considered, it does not have to be. Because of the nature of these communications, a few minutes more or less between sending and receiving points do not matter. Back-and-forth "conversation," to which TWX or private line teletypewriter service lends itself, is not required. Why use a superior facility when a slightly slower and more economical method will fully suffice? Moreover, the concentration of communications at the Signal Centers would permit a fuller and more efficient use of the intercity teletypewriter circuits. That is, transmitting the messages of many units over a unified network would spread the load and produce a more even flow of traffic, compared with the then existing situation of sporadic communications by individual users without regard to the usage of others. This was how the Signal Corps reasoned.

The Bell System Committee

IN NOVEMBER, 1942, the Bell System was asked by Brigadier General Frank E. Stoner, Chief of the Army Communications Service of the Signal Corps, and Rear Admiral Joseph R. Redman, Director of Naval Communications, for advisory assistance in connection with their respective leased-line telephone and teletypewriter services. This obviously involved a nation-wide review which was in some respects beyond the scope of any one Associated Company or Long Lines individually, and necessitated formation of a group representing the Bell System as a whole. Such a committee was formed, consisting of Myron F. Dull of the A. T. & T. Company's Department of Operation and Engineering, Richard W. Miller, Russell J. Anspach, and Roy S. Breese of the Long Lines Department, and Bruce E. Osgood of the Michigan Bell Telephone Company. Offices are maintained in the Pentagon, at Washington, permitting close daily contact with Signal Corps and Navy communications people.

One of the more specific requests made by General Stoner had to do with the Army Command and Administrative Network. Reduced to simple terms, he wanted to know whether this plan was likely to be the most effective among several which might be employed; if so, how many Signal Centers there should be and where they should be located; what the traffic volumes were likely to be between the Centers and how many teletypewriter circuits would be required to handle this volume; and what private-line service then being subscribed for by the Army might be integrated into this network.

When this committee first convened, with all of the potential communication problems of the Armed Services buzzing in its ears, so to speak, it faced a situation of tremendous size and complexity. Here was a mass of communication facilities to be surveyed, consisting of 400,000 miles of telephone and teletypewriter private lines, 2,600 TWX stations having a usage totaling roughly half that in the Bell System as a whole, scores of radio channels, and millions of message toll calls. Where to start? First things first, of course—but what should come first?

The First Question

THE initial problem in this regard was to decide as between the telephone and teletypewriter services. It was soon evident that the teletypewriter problems were the more pressing at that particular time. First of all, there was the importance of the written word in Army administration. Selecting teletypewriter service for first attention would, moreover, most quickly permit determining the relative effectiveness of the Signal Corps Network plan. Since this plan was actually in process of being placed in effect, a recommendation in this matter was indeed a first order of business.

This recommendation was soon forthcoming. A preliminary investigation made it apparent that the Signal Corps was proceeding along sound lines. The main problem was to expedite the conversion of many of the individual teletypewriter services and TWX usages into such a Network as quickly as possible. Speed in lightening the load on the general TWX facilities was indicated by a twofold urgency: that of service to the Army itself, which was encountering TWX bottlenecks caused by its own traffic volume; and service to the war industries and other government agencies which made up a large part of the remaining TWX traffic volume.

Compared with what had to follow, this was simple. The next problem—that of assisting the Signal Corps to engineer the Network—was staggering. Engineering requires facts: in this case, a great mass of detail. An outline of some of it—remembering that there were thousands of teletypewriter stations scattered throughout the country—will give some idea of the magnitude of the fact-gathering task:

For each private line teletypewriter service:

—the terminal points and the name and location of the Army unit subscribing for it.

For each TWX service:

—the name and location of the Army unit;
—the number and type of the teletypewriter machines;
—their recent usage; and
—the geographical concentrations, if any, in this usage.

IN ADDITION to the Army's coöperation the committee had, of course, the assistance of the Associated Company and Long Lines servicing forces. Regional meetings with representatives of these forces were held in Philadelphia, Washington, and Chicago, to discuss the problem and to seek their advice.

The servicing people of the Associated Companies and Long Lines, working with the Service Commands, promptly undertook the huge task of gathering and analyzing this information. These data were then reviewed by the committee, plotted on maps, and thus dovetailed to see if this enormous amount of communication facilities conformed to any nation-wide pattern, and, if so, what this pattern was.

Obviously, such a pattern had to be crystallized with a considerable degree of accuracy, since otherwise it would be impossible to recommend where the Signal Centers should be located and the number of circuits required. This analysis indicated that the Network might well be ex-

panded to include some 30 Signal Centers.

Parenthetically, this recommendation was complicated by the necessity for taking into account not only the Army's traffic but also the availability of telephone company facilities from which the needed circuits could be drawn.

Covering Ground

DESPITE the tremendous help given by the operating people in the field, the committee often found it necessary to familiarize itself with conditions at first hand. It is no exaggeration to say that one or another of the committee members has visited every important military establishment in the country at some time in its fact-finding activities. Transportation has varied from milk train to airplane. In one case, for example, in order to review the requirements of one large Air Force network it was necessary to visit establishments in Alabama, Florida, Georgia, Louisiana, Michigan, Mississippi, Ohio, Oklahoma, Pennsylvania, and Texas.

In addition to engineering the Signal Center locations and their interconnecting circuits, it was necessary to consider, jointly with the Signal Corps, which of the many Army units throughout the country could profit by access to the Network, and whether this tie-in should be by private line teletypewriter or other means. It was found that some 400 of them could advantageously route all or part of their traffic over the Network in addition to those which were already doing so. All told, about 20,000 minutes of TWX usage daily, mostly long haul, may ultimately be converted to the new Network—to the considerable relief of the general TWX facilities.

Among the committee's recommendations was the recognition that this Network should not be regarded as a rigid blueprint—in other words, that there might still be a number of situations in which the nature and volume of the teletypewriter traffic between specific points would justify separate private line service. Actually, the TWX usage data accumulated by the Associated Companies was combed with this in mind. It is perhaps a tribute to the alertness of both the military users and the Associated Companies that only three instances have been found in which it appeared more efficient to establish private line service.

Of this Administrative Network, it seems fair to say, in conclusion, that its existence will not only result in more efficient over-all communication; at the same time it may enable the Army to curtail increases in other private-line networks and forestall installation of new ones for the individual use of various Army branches.

Other Undertakings

THE FOREGOING presents a broad outline of only one channel of the committee's work thus far. Coincident with the reviews of teletypewriter services, analyses of long distance usage have been under way, and many recommendations have been made, looking toward economies in the use of critical materials and greater efficiencies in handling the intercity telephone communications of the Armed Forces. For example, consideration has been given to the extent to which private-line telephone service can be utilized effectively. An

experimental installation of private-line service between New York and Washington has been made and is now being analyzed. These studies should prove useful in considering the possibilities of similar installations in other parts of the country, with important effects on the efficiency and economy of Army long distance service in general.

As regards the results of this activity as a whole—in terms of both equipment conservation and improved communications efficiency—perhaps an example or two would be helpful at this point.

In the Pentagon, which houses the War Department in Washington, there were 67 teletypewriter stations, distributed among 26 different locations throughout the building. A study indicated that these locations could be better served by 31 machines if all were placed in the Pentagon Signal Center. There would be a saving of 36 teletypewriters, and an equal number of cable pairs and TWX switchboard appearances, although some allowance might have to be made for certain machines equipped with special apparatus. Completion of inward calls would also be vastly improved, with corresponding improvement in the speed of Washington TWX service generally—as well as specifically on calls completed to the Pentagon. There are numerous other advantages from an Army standpoint, including improved supervision of message handling and efficiency of attendants. This recommendation has already been acted upon in part, and will be carried further as conditions permit.

CROSS COUNTRY flight communications are vital. Air Force, Signal Corps, and C. A. A. representatives completed a review of these communications on April 1, 1944. The author (left) participated, covering 10,500 miles by Army plane, visiting important installations throughout the country

In a case involving the Navy, TWX communications between a certain East Coast establishment and points on the West Coast were extremely heavy—so much so that serious overloads, with resulting service delays, were being encountered on the transcontinental TWX circuits. It was found here that the substitution of private-line teletypewriter service would have multiple advantages: speed the handling of important Navy Department messages, help to relieve the general TWX traffic situation in the East Coast city—and, withal, save the Navy Department money.

A review of the Navy's telephone communications between important centers on the East Coast was also made. It resulted in recommendations, now being carried out, which will make material improvements in the efficiency of Naval communications.

Results

THERE IS, of course, no yardstick by which to measure an activity such as that which has been described. It is impossible, for example, to state in figures the results of the most important objective of this work—which is to assure that, in so far as practicable, facilities involving critical materials are being used to their maximum efficiency and that the users have the lowest possible costs consistent with adequate and dependable service. There are intangibles even in the matter of equipment conservation, although where it was feasible to accumulate such information, records have been made of the following savings:

26,000 air line miles of telephone circuits and 13,000 air line miles of teletypewriter circuits have been released for service in the general telephone plant;

900 units of teletypewriter apparatus, mostly teletypewriter machines, have been disconnected and made available for other uses;

$1,900,000 worth of communications equipment, either already in service or actually ordered for installation, composed largely of critical materials, has been saved.

Recommendations which result in such savings as these are, of course, made only where they will at the same time produce a satisfactory service. Incidentally, these conservation achievements will be accompanied by savings in the Armed Forces' communications expenses of approximately $3,500,000 annually, counting the recommendations for changes which are now in process of being effected.

But the foregoing are only what might be termed the "positive" savings: those which pertain to facilities actually discontinued or those on order which were canceled. There have also been uncounted savings, attributable at least indirectly to some of this work, in equipment which doubtless would otherwise have been ordered but was not. Joint efforts of the communications branches of the Armed Forces and the committee, through meetings, letters, and bulletins, have fostered a "conservation consciousness" in the far-flung Army and Naval organizations. In June, 1943, for example, all Service Commands were called upon to release telephone instruments and TWX stations considered not absolutely essen-

tial; similar action was taken by the Navy. Whereas prior to June there had consistently been an increase in TWX stations subscribed for by the Armed Forces, there has since been a continuing decrease. Some 14,000 telephones have also been released.

Wherever expansion of the Army's Administrative Network has been recommended, the necessity for action to insure continuity of experienced people has been emphasized. The very first report to General Stoner recommended the use of WACs, and these young women are now being assigned for the all-important Signal Center operation. Practically all of the training of teletypewriter operators used on the large Army networks had, initially at least, been given by Bell System instructors. Now, however, because of the vast increase in its requirements, the Army plans to train some of its own people as instructors. It was recognized that, to facilitate this, some of the A. T. & T. Long Lines Department's training material would prove useful, and this material was revised and made available to the Army.

Furthermore, the information gathered for the analyses has provided the Army with basic data to assist in establishing its own system of record keeping. These records have better enabled the Army to visualize its communication problems and formulate judgment with respect to desirable equipment rearrangements, additions, and deletions.

THIS STORY could not properly conclude without a word of personal comment, on behalf of the entire committee, regarding the wholehearted and friendly coöperation which has been received throughout from the members of the Armed Forces and from Bell System people with whom the committee has dealt. Such contributions as the committee has been successful in making to the work of the Army and Navy, and thus to victory, have been due in large measure to this very willing and indispensable assistance.

THE NATIONAL SECURITY AWARD, established to "recognize superior organization for plant protection and security," has been granted simultaneously to the Associated Companies and the Long Lines Department of the Bell System by the U. S. Office of Civilian Defense.

"The coöperation of the telephone industry in civilian defense and war programs has been so complete and so thorough that it is an outstanding example of the patriotic conversion of an entire industry to wartime needs," said Lt. Gen. William N. Haskell, Director of Civilian Defense. "For security reasons, we cannot yet tell the whole story of the many measures which the telephone companies have taken to safeguard our vital lines of communications during these war years. However, we can say that in setting up complicated warning systems and in other ways the telephone companies have extended to Civilian Defense a high order of coöperation."

In This Conflict, for the First Time in History, Radio Telephony Permits a Sea Commander to Dispose His Ships Wherever He Chooses over the Broad Area of Battle

The Telephone Remakes Naval Warfare

Fletcher Pratt

The phrase "The telephone has gone to war" means, among other things, that the telephone industry's manufacturing capacity is now devoted almost wholly to producing electronic and communication equipment for the nation's armed forces. That explains in part why there are not enough telephones to "go around" among civilians. In the following article Mr. Pratt gives an authoritative picture of the telephone's part in several crucial naval actions of the present war; and from it the reader may infer the urgency of concentrating the production of communication equipment on combat items.

THE NAVAL WAR of today differs more from that of World War I than the latter did from the Civil War of 50 years before. This is obvious when we compare the swift whirlwind action of ships all over the ocean that Guadalcanal and Midway saw with the long lines of battleships at Jutland twisting and weaving through an afternoon—just as they did in the days when Lord Nelson expected every man to do his duty under tall pillars of sail.

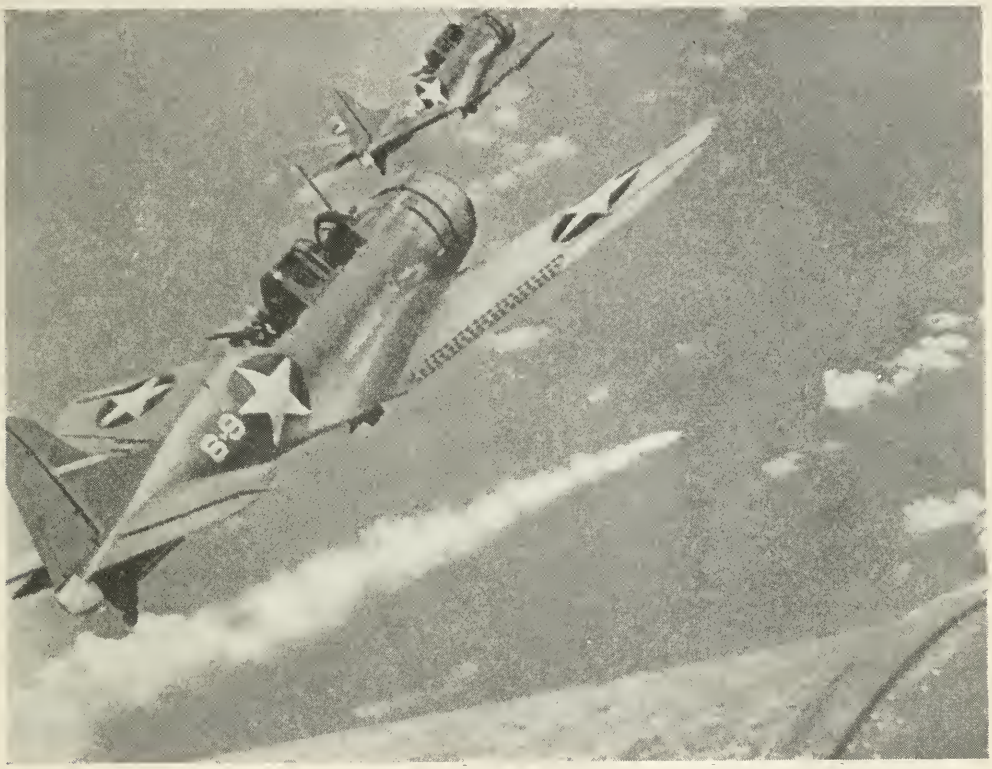
The airplane has something to do with the change: at Midway one of the most desperate battles of modern times was fought out without the ships coming in sight of each other. But this and other differences are of weapons merely; they time the naval battle for midnight or move the opposing fleets apart as they had already been moved apart by the range and power of modern artillery. The essential structure of the naval battle would have remained unchanged but for the appearance of another new weapon.

That new weapon is the telephone.

Specifically, the radio telephone, both in its long-range form and in the more limited variety known in

the navy as the TBS ("talk between ships").

Its beginnings were toward the close of the last war, among the tiny motor sub-chasers working to keep the English Channel free of U-boats. In addition to the earliest radio telephones, they carried the first crude sound gear for locating submarines, which would give them the direction but not the distance of the enemy's motors, heard under water. Accordingly, they worked in groups of three. When sub-chaser 316 (for instance) heard the exciting noise, it would open up its TBS to tell the other two working with it "I have a submarine on bearing 345." Sub-chaser 317 would listen and reply, "He bears 194 from me"; and sub-chaser 318, "He bears 092 from where I am." On all three sub-chasers, officers would draw lines on charts in the directions given; where the three lines intersected, the U-boat would infallibly be; and they could trot over and drop depth charges.



OFFICIAL U. S. NAVY PHOTOGRAPHS

DEATH OFF MIDWAY. In an enlargement from an original 16 mm. film, this photograph shows Douglas Dauntless dive-bombers making their run before dipping down to smash at Japanese warships during the titanic battle of Midway in June, 1942. This picture, made on June 5, 1942, shows one Jap warship burning fiercely far below.

The TBS of those days was a pretty

ineffective instrument, no use unless the ships carrying it were but a few hundred yards from each other—and not much use even then. But if the British had had even so imperfect an instrument at Jutland, they could probably have wiped out the German fleet and shortened the war. Communications in that battle were mainly by searchlight and signal flag, because the coded radio was too slow. Admiral Jellicoe had to keep all his ships in close visual touch with each other. As a result, the well-beaten Germans slipped round his massed ships during the night and got away to harbor. During a great deal of the battle, in fact, the British admiral did not know where all his own ships were. With TBS, he could have used his battleships in long open formations, concentrating against the enemy the moment any of them made contact.

That is, the telephone, so much faster and more accurate than written radio telegraph dispatches, permits a sea commander to dispose his ships wherever he chooses across the broad area of battle, summoning them together for sudden attacks on a wing of the enemy's fleet. It is no longer necessary, as in all the past history of naval war, for the admiral to be in the leading ship, with the others strung out in a long, rigid line behind him, conforming to the movements of the flagship because there is no sure way of telling other ships what he wishes them to do. In fact, the

NIGHT ACTION. In battles like this, fought at hot speed with ships close to each other, communication would be impossible without the use of such devices as the radio telephone

admiral does not have to be on a ship at all.

This is illustrated in a minor sense by one of the most difficult of naval operations: the making up of a convoy. It involves bringing out of port and into formation at sea many ships, of varying speeds, whose captains do not have the training of naval officers in precision maneuvers and split-second timing. Directions to the ships from the convoy commodore by flag signal were often misunderstood; using radio telegraph is an invitation to every submarine within hundreds of miles to come jump on the convoy while it is least able to take care of itself. But these days the convoy commodore can go aloft in a blimp or plane and, opening up his short-range radio telephone, talk to each ship in turn or all together, telling exactly where he wants them to go and at what speed.

The Battle of Midway

Our navy has used the radio telephone in the tactical field also, with outstanding results. Midway would have gone into the books as a drawn battle or even an American defeat but for this.

"Scratch one flat top!" The Japanese carrier *Ryukaku*, hit and exploding in the Battle of Coral Sea

Consider the situation on that morning of June 4, 1942. The Japs had violently attacked the island, and planes from Midway had counter-attacked the Jap fleet, damaging some of its vessels. Their carriers had turned away under cover of an overcast to refuel planes. Our own car-

riers had flown-off their attack groups of torpedo- and dive-bombers but, thanks to the Jap movement and the clouds, these were hunting for the enemy in vain, all but one group—the famous Torpedo Squadron 8. They found the Japs, but their fuel was running low. Squadron Leader Waldron opened up his voice radio and gave the position. "Request permission to return to carrier for fuel," he added.

Now, he was the man on the spot, an able leader and a first-class fighter. Without the voice radio, his judgment would have been the ruling one on what to do, and his judgment was to break away. But Admiral Spruance, to whom he had spoken, knew better; knew that the dive-bombing groups and the rest of the torpedo planes were only a few minutes' flying time distant; that if he recalled Torpedo 8 now, the Japs would almost inevitably find his carriers and hit him before he could hit them. "Attack at once," he telephoned back, and at the same time notified the rest of the planes where the enemy was. All our groups poured in on the Japs in one of the greatest airplane attacks ever delivered, sank four enemy carriers, saved Midway, saved Hawaii, and saved the war for us right there!

In the Coral Sea

THE NEW dispositions made possible by telephone were perhaps even more decisive in the strategic range during that earlier confused, desperate four-day series of sea-air fights which are called collectively the Battle of Coral Sea. The problem in that case was one of information, with neither side knowing the strength or intentions of the other. Actually the Japs had four complete fleets in the area: two of them invasion groups consisting of transports covered by such light craft as cruisers and destroyers; two of them powerful carrier striking groups including battleships. One of the battle fleets was covering one of the invasion groups as it swept down from the north to set up a new base on the islands at the eastern tip of New Guinea. The second invasion group was similarly occupying Tulagi Harbor and the island of Guadalcanal in the Solomons, while the other battle fleet was swinging wide to the east around the Solomons to trap in the Coral Sea any American forces that might try to interfere.

Admiral Frank Fletcher was in that sea with the carriers *Lexington* and *Yorktown*. On the afternoon of May 3 one of his scouts just lifted a wing over Guadalcanal and spied the Jap invasion fleet at anchor. "Joan to carrier," he said over the voice radio; "concentration enemy shipping Tulagi Harbor." At the same time Fletcher had word from Australian air scouts of the great double Jap fleet coming down toward the tip of New Guinea. He had located three-quarters of the enemy armada, so much larger than his own, and they did not know of his existence—at least not till the dawn of the morning of May 4, when the planes of the Yorktown's powerful striking force fell on Tulagi from the sky and wiped out the Jap invasion fleet there for our first victory of the war.

AS SOON as he had won it, Fletcher turned west and steamed at hot speed for the waters south of New Guinea. Once more the Japs did not know of his presence, for he had used only

short-range voice radio telephone—and so kept them from getting a fix on him with their radio direction finders. When, on the morning of May 6, the striking forces were flown from the *Lexington* and *Yorktown,* they found the Jap carrier *Ryukaku* just turning into the wind to launch planes, and slapped at least 10 torpedoes, at least 15 heavy bombs into her. Commander Dixon opened up his long-range radiophone to shout the jubilant message that has become a classic: "Scratch one flat-top."

Now the interesting thing about both the Coral Sea and Midway actions is that they were, in a sense, conventional naval battles. The use of airplane striking forces had moved the fleets out to 200 miles apart instead of the 200 yards of the days of sail, but the procedure was essentially what it had always been. The admiral's flag was on the leading and most powerful unit; the others followed her movements but used their offensive powers (in the two cases, airplanes) pretty much at their own

Battle by night in Kula Gulf. Most naval actions in this war have been fought in the dark and have lasted only a few minutes. The TBS circuit enables captains to get in direct communication with and identify their neighbors

discretion against whatever ships of the enemy they chose. There was some tactical difference between Coral Sea-Midway and the old pattern of battle, to be sure; a difference brought about by the telephone in the form of TBS. But it seemed a minor matter at the time.

Signals vs. Speech

THIS DIFFERENCE lay in the exquisite control over his other vessels that an admiral aboard a carrier was able to exercise through the new instrument. When Jellicoe at Jutland wished his leading division of ships to alter course or speed, he had to tell his flag lieutenant, who wrote an order which the Admiral OK'd, reading something like "Flagship intends to turn five points to port and proceed at 18 knots."

This message was passed to the signal bridge, where the crew selected the proper flags, arranged them, and hoisted them to the yardarm. The ships to which the message was addressed read it, and ran up the same flags to show they had understood. When they had all done so, the Admiral would give the order *"Execute"*; down came the flags, the Admiral's ship speeded up and made her turn. The whole process took as much as ten or fifteen minutes, and on several occasions during the smoke and confusion of the Jutland action some ships missed the signal so that the *Execute* was never given at all.

We can note that this process is altogether too slow for an action involving planes, whose attack is all over, success or failure, in the time necessary to give the signals. Without their TBS, Fletcher of Coral Sea and Spruance of Midway would really have had no communication at all during the hottest and most vital parts of the battles. But they did have TBS; they were able to pick up a phone and talk direct to the captains of the ships under their command, saying for instance, "I'm going to turn five points at twenty-eight knots." The process took no longer than it does to pronounce the words, the acknowledgment the same, and there was no chance of error. The admiral could even order the ships of his command to perform quite separate evolutions, or order all of them to fire on the same enemy.

The Battle of Guadalcanal

WHETHER anything like this was attempted at Coral Sea or Midway we do not know, and shall not till after the war, when the track charts that show the movements of the ships are published. But it is clear that the full possibilities of the telephone in naval war were realized and used at least by the night of November 15, 1942, in that tremendous and decisive action known as the Battle of Guadalcanal.

The Japs had come down from the upper Solomons with a squadron of battleships and cruisers to shell our positions on the island, and to bring reinforcements for their own positions aboard a fleet of transports. They had done it before, sometimes losing, sometimes winning, but never in such strength, and the battle for the island had reached its crucial stage.

That night Rear Admiral Willis Augustus Lee appeared off Guadalcanal with two American battleships. They steamed past the capes of the island, and picked up the approaching

Jap squadron. And it was with his TBS that Admiral Lee arranged a concentration on the leading Jap battleship. "Commence firing!" he said into the mouthpiece when he was sure both ships had the same target. They opened up together, hitting that Jap so quick and so hard that she never had a chance to reply, never fired a shot—and in five minutes 27,000 tons of battleship were on the bottom and the battle was won. The other Jap ships fought on, but the advantage gained by that first crashing concentration was such that the decision was taken and Guadalcanal was won.

More than that; for, as that action proved, the change in communication introduced by the radio telephone has brought about a complete change in the conduct of naval war. As soon as this was realized, and used to its fullest extent, we won a major campaign.

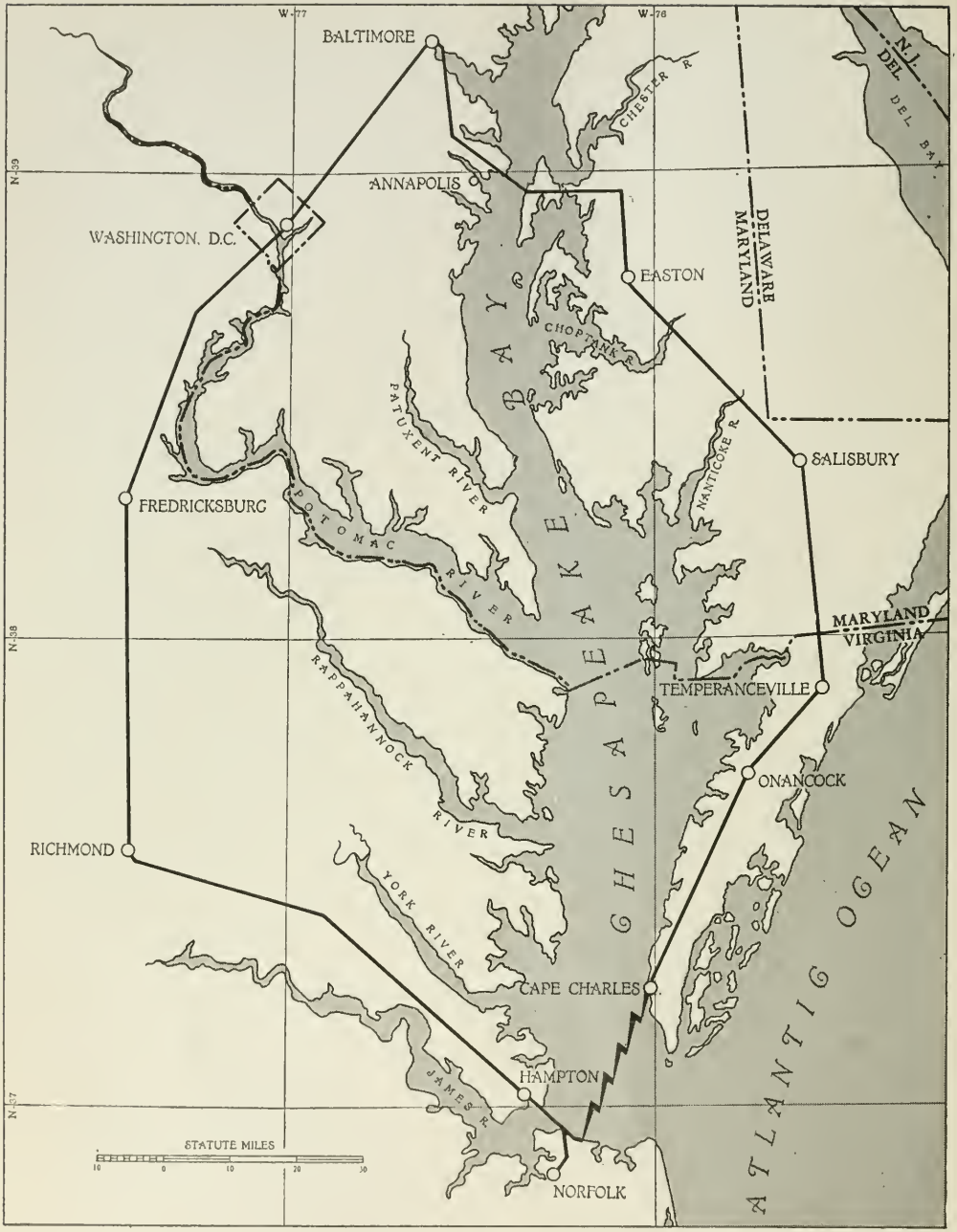
MY FINGERS build a bridge of words that spans the long miles between a lonely boy and home. Troops move and factories thunder into action obedient to the calls that speed through my switchboard.

A mother, a sweetheart, a wife wait by their telephones as I try to reach the soldier in camp or the sailor on shore leave. And usually I succeed, for I know the love and longing that lie behind those long distance calls.

The hopes, prayers, and fears of a nation at war are in my keeping, for I guard the lines that unite the continent. I am a part of every plane that flies and every ship that sails the seas, for without long distance calls they could not have been built.

My job is one of the most important war jobs in the world. My responsibility is great, but my pride in it is greater, for, although I am unseen and unknown, I fight at my switchboard with the spirit of my brother with the gun.

By Patricia MacGill, evening toll operator, Miami, Fla.



A DOZEN telephone conversations at one time may leap across the mouth of Chesapeake Bay, instead of pursuing the circuitous route of the solid line, thanks to the application of carrier techniques to radio telephony

Type-K Carrier Techniques as Applied to Radio Telephony Provide Additional Circuits into an Important Region and Illustrate Another Advance in the Telephone Art

A Bridge for Speech across Chesapeake Bay

Austin Bailey

A BEE LINE between the towns of East Ocean View and Cape Charles, Va., across Chesapeake Bay near its mouth, is only twenty-five miles. And as the bee, so do telephone conversations now fly across that stretch of water: straight, and through the air. For since late in 1941 a unique radio system has spanned these waters. By means of this new speech bridge, telephone conversations can now go back and forth across, instead of more than four hundred miles around, Chesapeake Bay. Not only does the radio link shorten this telephone path, but it provides additional toll circuits into this Middle Atlantic seaboard region.

To the communications engineer, however, the significance of this radio link is not alone in the substitution of a 25-mile radio bridge for a 400-mile land route. It is in the character and performance of the link itself; for it represents an unusual illustration of the telephone art's development—a system that adapts the "carrier" technique to radio and provides twelve talking channels in a single radio frequency band.

More than a decade ago, engineers of the Bell System were considering ways to span the barrier of Chesapeake Bay with telephone circuits along the Atlantic Coast. Consideration was given to both submarine cable and radio as a means for doing this. Either way would be expensive, and each offered certain advantages. Tides, winds, and dragging anchors were some of the hazards to be reckoned with, as well as the vagaries of radio transmission. Moreover, it was fairly obvious at the beginning, from a knowledge of the region and the community of interest between the shores of the Bay, that a single voice channel would not adequately meet the demand for service. Several channels that could simultane-

ously carry telephone conversations would be needed—and of course this made the problem even more complex.

Complex the problem was, in its various aspects; but the answers were all found, and the system is working as the engineers planned. How the problem was solved is the subject-matter of the following pages.

In this building at Cape Charles are installed both the radio equipment and the equipment to convert 12 wire telephone channels into the single radio channel

An interplay between the allied telephone arts of transmission over wires and by radio has long been fruitful of progress to both. As an example, the vacuum tube, developed first as a radio detector, was improved and modified to become the "repeater" tube used in long wire circuits. And then the ability of this improved vacuum tube to increase the strength of signals made possible more practical and more powerful radio telephone transmitters. This same kind of thing has taken place in many component parts and even in more complex systems and circuit arrangements, as the science of telephony has made its great strides during the past two decades or more.

Radio telephone systems from the first employed different frequencies, or bands, to separate individual stations. One could "tune in" this station or that by adjustment of the radio receiving device. The radio transmitters likewise were tuned to send their signals on certain frequencies, much as one tunes the strings of a musical instrument to sound certain notes of the musical scale. This

radio technique of separating channels for communication by "tuning" was applied to wire systems, and made possible multi-channel operation of the present-day "carrier" systems.

It is fairly obvious to us now, because of our own experience with radio broadcast receivers, that by means of "tuning," any one of a number of communication channels can be selected from the programs picked up by the antenna. In this way, then, a single wire circuit may have a number of communication bands sent into it, and at the other end these bands may be separated by "tuning"—as is actually done in carrier systems. Development has made it possible to put these bands very close together, and thus to transmit a number of them on a single wire circuit. These carrier systems are now extensively employed to obtain additional telephone channels over wires.

Among these carrier systems is one known as the Type K.* This system was first put into commercial use on telephone cables near the close of 1938. It is capable of transmitting twelve telephone conversations simultaneously without interference between them. It seemed that twelve telephone channels would be about the right number to provide for the immediate need for circuits across Chesapeake Bay and to allow for expected future growth. Consequently,

At East Ocean View, on the lower side of the Bay, only the radio equipment is installed. The conversion equipment is housed in the Norfolk toll office

* See "Twenty Years of Carrier Telephony," Bell Telephone Quarterly, October, 1938.

it was decided to undertake the development of a radio system that would be capable of transmitting all the bands of a Type-K cable carrier system as a single wide radio band.

Experience has taught those working with carrier transmission on wire lines that the step from an idea to an operating commercial system is not an easy one. There are many ramifications, such as special treatment of the wire circuits themselves to keep the carrier channels on the assigned paths, refined technique in building equipment, and greater loss in power which necessitates more closely spaced repeater points.

In much the same way, to put a number of telephone channels on a single radio transmitter simultaneously imposes new requirements on its design, to prevent interaction and interference between the several paths and to provide increased power to care for the greater band of frequencies transmitted. It was at first doubtful whether this could be done economically at all; but these problems were solved by Bell Telephone Laboratories engineers, and radio equipment was built which is capable of handling satisfactorily the output of Type-K cable carrier equipment.

How "Carrier" Works

In order to understand better what happens to a telephone band in the Type-K cable carrier system, reference should be made to Diagram A. The blocks lettered A to L inclusive represent bands of frequency space wide enough to transmit the frequencies ordinarily of importance in a telephone conversation. Each block represents, then, a telephone band. The position of each block across the top of the table represents its absolute frequency. As the telephone conversations arrive at the terminal of the Type-K cable carrier system over separate wire circuits, they all occupy the same frequency space. This is represented in the diagram by the pile of blocks on the corner of the table. The electrical equipment in the terminal converts each band to a new absolute frequency for transmission over the wire circuit. In the diagram, this is represented by putting each block on the table top in a line nearly side by side along the front, A′ to L′. These bands in this new arrangement can then be transmitted to the other end of the system and there again restored to the original frequency positions, to be distributed over separate wire circuits. This, in turn, would be shown in the diagram by pushing the blocks to the back of the table top for transmission over the line and by piling them up again on the left hand back corner for the frequency conversion that takes place in the receiving carrier terminal. By this process we have been able to push individual blocks to the back of the table all on one surface, while from the pile twelve shelves would have been needed to do this. This is analogous to the use of a single wire circuit instead of twelve to transmit the twelve telephone conversations.

In ordinary broadcasting, only one band or block of frequencies is used to control a single radio transmitter at any time. When the radio receiver is "tuned" to any particular position on the dial, in general only one program is heard. But there is really nothing very different physically between using a relatively narrow band

with a single program or a wider band with more than one. If the radio equipment were specially designed, we could either employ the block of frequencies represented by A in the diagram or a large block that would be represented by the space including A′ to L′ in the diagram. This latter is what was actually done for the equipment used to build the "speech bridge" across Chesapeake Bay.

To obtain radio assignments with width great enough to accommodate the twelve telephone bands corresponding to the blocks A′ to L′ inclusive, it was necessary to employ very high frequencies, even higher than those now employed for FM (frequency modulation) broadcasting. A band in the very high frequency region was available, and the radio equipment was assigned to operate in this range. Furthermore, the special design included the ability to accept a group of telephone bands from the Type-K carrier system such as represented by blocks A′ to L′, extending from 12,000 to 60,000 cycles per second, and to control (or "modulate") the radio carrier with this group all at once. Currently, radio assignments in this region are on the basis of a band width of 150,000 cycles per second for a single communication channel, but by this system

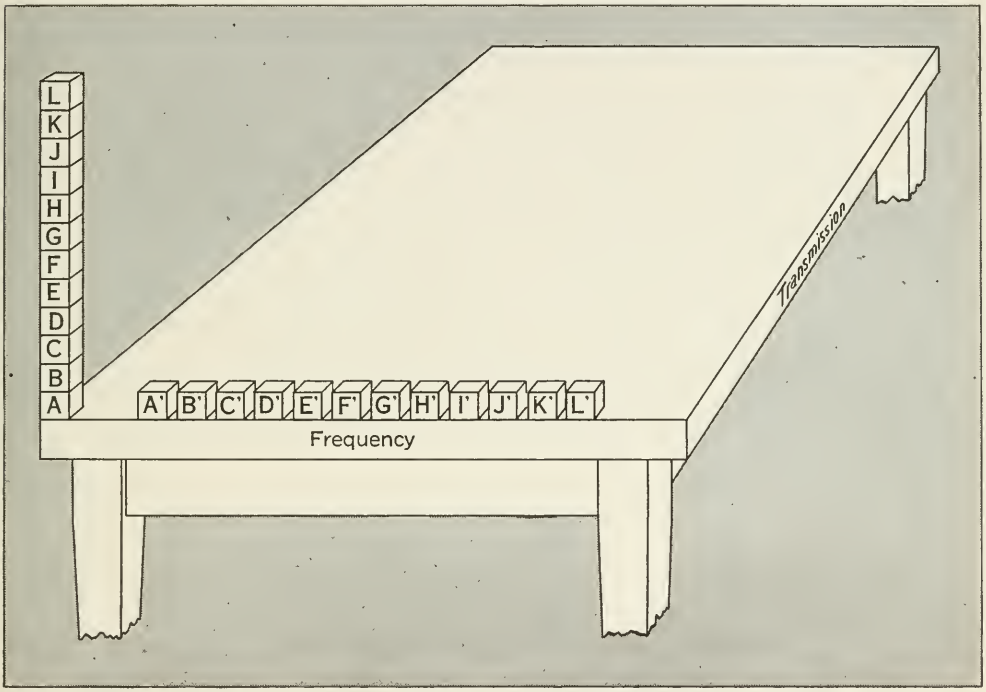


Diagram A. Representing by analogy the frequency transformation and transmission of Type-K carrier channels, this diagram illustrates the explanation which begins on the opposite page

twelve voice communication channels have been put into this same band width, representing an enormous conservation in the utilization of the channel space assigned from the radio spectrum.

STILL ANOTHER consequence following from the use of such very high frequencies is that very little noise from external sources affects the system. Man-made electrical disturbances in this region of the radio spectrum are exceedingly small, while static, even during an electrical storm, can be detected only infrequently. This generally low noise level reacts on the system design to make possible the use of less transmitting power than otherwise would be required.

The wave length in free space of the radio frequencies employed is about six feet. Such a small wave length has real advantages in designing antenna structures with high efficiency and directivity, because the parts can be close together and rigidly constructed.

These very high frequencies are propagated through space very much like light and obey essentially the same laws. From this it follows that the transmission path between the radio terminals should be substantially a path over which one terminal antenna could be seen from the other on a clear day. Limited only by the earth's curvature, a point 200 feet above the surface of the earth can be seen from a similar elevation about 35 miles distant. It is apparent, therefore, that the antennas at the two ends of the path across Chesapeake Bay—about twenty-five miles—could be less than two hundred feet in height.

With information of the nature outlined roughly above, but of course with scientific accuracy of detail, engineers of the Chesapeake and Potomac Telephone Company, the Bell Telephone Laboratories, the Western Electric Company, and the A. T. and T. Company devised a bridge for words to cross the waters of Chesapeake Bay. Near the town of Cape Charles, Virginia, land was acquired, a building constructed, and a steel tower erected. In the building was installed all of the equipment necessary to convert the twelve telephone channels into a single radio channel. At East Ocean View, about ten miles from Norfolk on the shore of Chesapeake Bay, similar work was accomplished, the building, however, being smaller because only radio equipment is installed at that location.

While this construction work was in progress in Virginia, the Laboratories and Western Electric were busily engaged in building and testing equipment units. Next came the period of installation and testing, first at one end, then at the other; and, finally, the over-all system from Norfolk to Cape Charles. Installed in the Norfolk toll office are the Type-K carrier equipment and system control and testing units. Such was the magnitude of the project that more than two years were required to complete the work.

How the System Works

PERHAPS a clearer picture of the whole wire, carrier, and radio system may be obtained from a simplified diagram of the relation between its more important components. Referring to Diagram B, suppose a telephone subscriber in Onancock or

Cape Charles wishes to talk with someone in the vicinity of Norfolk. He places the call just as he would a call to any other distant point. Following the usual operating method, the toll operator rings Norfolk on this newly established toll circuit, and passes the necessary details. Connection to the called telephone is established in the regular manner, and the conversation proceeds.

The subscriber at one end actuates one channel of the Type-K carrier terminal. This block of frequencies is then used to control the radio transmitter, and the radio waves are sent out across Chesapeake Bay to be received by the distant radio receiver tuned to accept the wide band which includes all such blocks. The individual block is then "tuned in" by the Type-K carrier equipment and changed back to the original absolute frequency to be transmitted over the wire circuit to the distant subscriber. The process in the reverse direction is much the same, the only significant difference being that in the radio part of the circuit a different radio frequency band is used to prevent the nearby radio receiver from picking up the local radio transmitter.

Each receiving Type-K carrier channel is definitely associated with a corresponding channel in the opposite direction to avoid any possibility of selecting the wrong return channel for any conversation. All the tuning

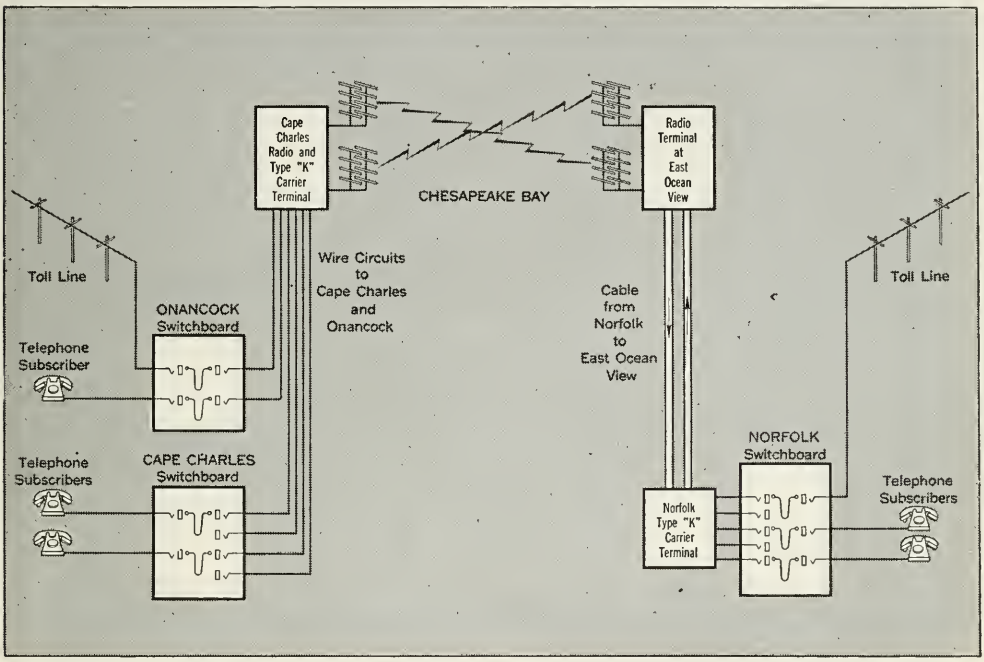


Diagram B. The interrelation among the several parts of the system, as described in the accompanying text, is represented diagrammatically above

and selecting has been done once for all in the manufacturing of the equipment. The radio terminals are unattended.

In addition to the circuit components indicated in the simplified diagram, remote control and testing facilities are provided in the Norfolk toll office which, by means of alarms, indicate any abnormal operation of the system. In case a failure should occur, the source of trouble can be quickly localized by the remote testing facilities provided, which enable, first, a determination of which terminal is at fault, and then whether the fault is in the sending or in the receiving path. The entire system is normally supplied with electricity from commercial sources; but, should there be an interruption of power at any of the stations, fully automatic emergency sources of power come into operation to restore the system to service.

PICTURED HERE is some of the testing and control equipment associated with the system. The author of this paper stands at the left

HERE THE voice currents from a dozen wire circuits are transformed for transmission on a single radio telephone circuit—and vice versa

As previously mentioned, the antennas are supported on steel towers slightly less than 200 feet in height,

Regulations of the Civil Aeronautics Administration require special painting and lighting on such tall structures because they may be hazardous to civilian air navigation. Under certain conditions, where such structures are strategically located, they may, if properly lighted, prove to be aids to air navigation. Because of the location of the tower at East Ocean View, the lighting on this tower was established in conformity with the national standards for a beacon light, and is operated nightly from before sunset to after sunrise. The emergency power facilities provided by an automatically operated gasoline-driven engine alternator insure dependable operation. In recognition of the value of this beacon as an aid to air navigation, the Civil Aeronautics Administration has issued a certificate of "true light" to the Chesapeake and Potomac Telephone Company of Virginia.

INTERIOR of the East Ocean View station. At the right is the radio transmitter with its rectifier unit, and in the adjacent bay the line circuits and testing arrangements. At the left is the radio receiver. The fireproof door at the rear leads into a room housing the emergency power-supply apparatus

When the tests were finally completed and the system across Chesapeake Bay declared ready for service, it seemed desirable to break down this group of twelve circuits into several direct circuit links, in much the same way as would be done with the wire circuits in a telephone cable. All circuits terminate in Norfolk on

the south end; but to the north, five out of the nine which are assigned to general telephone service are terminated in Cape Charles and appear in the operator's switchboard at that point, while four circuits terminate in Onancock, which is the toll center for this Eastern Shore area.

To the telephone user, it makes no difference whether his conversation is over this radio bridge across the Chesapeake or by another route. The important thing is that, through such a span across a natural barrier, alternative routes become available whereby congested circuit conditions can be relieved and the reliability of communication by telephone can be further improved. Again the Bell System has put into service a new scientific achievement which makes possible through advances in the radio and carrier techniques a welding of the two, to provide a means for transmitting simultaneously as many as twelve telephone conversations across a barrier on a single radio channel.

"If I were asked to cite specifically the document originally embodying the importance of this 'personnel' concept of public relations I should choose the A. T. & T. annual report for 1902. It reads: 'An essential obligation on the part of this company and the operating companies with which it is associated is to use every effort to give their patrons the best possible service. To do this the apparatus must be of the best design and quality, and must be installed under the most favorable conditions.' And here is the new thinking of 1902 which I ask you particularly to note: 'More than that,' the report goes on to say, 'the working force including not only the telephone operators who come into contact with the public, but all those upon whom is imposed the duty of keeping the apparatus in order and of arranging with the public for its use must be thoroughly trained, as well in the practical part of their work as in meeting and dealing properly with the public.' Here we see how forty years ago there began to emerge the recognition of employees—all employees—as valuable media for public relations. And today we see the results in the uniformly good reputation which the Bell System enjoys."

From an address, "Public Relations—the Reagent of Business," before the Advertising and Sales Executive Club of Montreal by Herbert H. Lank, Vice President, Canadian Industries.

Morse's First Telegraph Message, Dispatched a Hundred Years Ago, Began an Era of Faster and More Effective Ways of Sending the Written and the Spoken Word

A Century of Electrical Communication

Robertson T. Barrett

On May 24, 1844, a small group of people was gathered around a table in a chamber of the United States Supreme Court at Washington. On the table rested what must have been, to them, a fascinating collection of apparatus. Over this bent a man of middle age—smooth-shaven, tall, lean almost to the point of gauntness, with deep-set eyes.

Glancing at a slip of paper which he held in one hand, he reached with the other toward the apparatus, or part of it. His hand moved up and down. His audience heard a series of faint, almost indistinguishable clicks. There was a pause. Then from another part of the apparatus came a succession of louder, sharper clicks, as a stylus attached to the end of a moving lever marked a series of dots and dashes on a paper tape.

"There your are, Miss Ellsworth," one may imagine him saying, as he turned to a young woman by his side. "There is your message, transmitted to Baltimore and back again, just as you wrote it out—*'What hath God wrought!'* "

The man at the table, now smiling almost triumphantly, was Samuel F. B. Morse. The dots and dashes, faintly impressed upon the paper tape, had spelled out the first telegraph message ever transmitted by means of his invention over so long a line as that which, with funds appropriated by the United States government, he had built between Washing and Baltimore.

This scene, enacted just one hundred years ago, was more than an episode; it was an event. It marked the beginning of a new chapter in the long history of men's effort to send their thoughts, expressed in written or spoken words, swiftly and surely to places far distant. With it began the era of successful communication by electricity.

In the advancement of the communication art during the past eventful century, whether in the telegraph field or in that which is more particularly their own, those who provide America's telephone service may take pardonable pride. The history of the telegraph and the history of the telephone are both parts of the greater history of electrical communications.

MORSE had conceived the idea which ripened into the invention of the telegraph while returning from Europe in 1832. During the twelve years that separated this birth of the telegraph idea in the mind of Morse and its final fruition in success, he had experienced many bitter hours of discouragement. There were periods during which the grim facts seemed to counsel that he forget his invention and return to his career as an artist, in which he had achieved no small reputation. When such dark days came, Morse refused to believe the facts, and held firmly to his faith. Deeply religious, and something of a mystic, he clung to the belief that he was an instrument of divine will, and that some intervention of Providence would guide him out of every failure to final success.

Out of one such period of discouragement had come the selection of the scriptural words, from Numbers 23: 23, that made up the first telegraph message. Morse had succeeded, early in 1843, in having a bill introduced in Congress appropriating $30,000 for the construction of an experimental telegraph line. The bill passed the House by the narrow margin of 89 to 80. Morse went to Washington to watch its further progress, and to expedite it if he could. While in that city he renewed his friendship with his Yale classmate, Henry L. Ellsworth, Commissioner of Patents, who, with the members of his family, strove to help and encourage the inventor.

Morse needed encouragement. Things were going badly with the telegraph bill in the Senate, which delayed action as the legislative session drew toward its close, on March 3. All through the weary hours of that day the inventor sat in the Senate Chamber, watching and hoping against hope as the proceedings dragged on. There were more than 140 pieces of proposed legislation to be acted on before his could be reached.

He asked two senatorial friends what the prospects were for the passage of his bill. Later he wrote: "Their answers were discouraging, and their advice was to prepare myself for disappointment. In this state of mind I retired to my chamber and made all arrangements for leaving Washington the next day."

A Joyous Surprise

THE NEXT MORNING, while at breakfast, he was surprised at the announcement of a waiter that a young woman wished to speak with him. He was greeted by the smiling face of Miss Annie Ellsworth, daughter of his friend the Commissioner of Patents. To his surprise, she said:

"I have come to congratulate you."

"Indeed, for what?" asked the perplexed Morse.

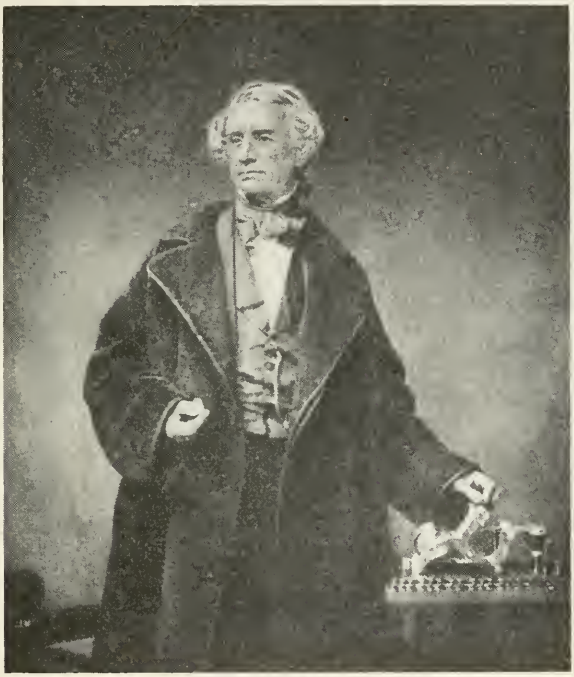
"On the passage of your bill," was the girl's beaming reply.

It was difficult for Miss Ellsworth to convince Morse that what she had

told him was true. Finally he said "You are the first to inform me, and now I am going to make you a promise: the first dispatch on the completed line shall be yours."

More than a year was occupied in the construction of the line, but he did not forget his promise. The words selected by Miss Ellsworth for the dispatch, as has been said, were: "What hath God wrought!" In his hour of success, following twelve years of disappointment and apparent failure, they must have seemed particularly appropriate to Morse. His was a faith, not alone in himself and in the soundness of his idea, but in the possibility of divine intervention in the affairs of men, to bring about what the facts had repeatedly said was impossible.

Morse must have had an equally firm faith that events would prove that there was a need for his invention—as they were to do. This moment of success could hardly have been timed more fortunately. The era was ripe for some new and swifter form of communication. National necessities demanded it. During the next century, these necessities were to become more and more urgent, and would demand still more effective means of speeding the written word, and the spoken word as well.



Sam'l F. B. Morse

Some of these needs were eco-

nomic. The pressure of population was accelerating the pace of the conquest of the continent. For all except the most conservative, life along the eastern seaboard was becoming too crowded. Men wanted elbow-room, and sought it in the West. They traveled. Little bands, at first, and then great caravans, began to make the long journey across plains and mountains. Within a few years after Morse tapped out his famous four-word message, a man was to find, in a California creek bed, a nugget of gold. The slow march of the settlers became literally the rush of frenzied feet. On the heels of trappers and missionaries who had blazed trails toward the setting sun came the "Forty-niners." Men were being pulled westward by the hope of new opportunities as well as pushed westward by the pressure of rapidly increasing population.

The Westward Urge

As POPULATION in the East became more concentrated, moreover, men had to send farther and farther for life's necessities. Railroads, over which a few locomotives were puffing uncertainly when Morse conceived his telegraph idea, grew apace. Each mile of track that was built was an answer to a growing need for swifter means of transportation, not only for passengers and goods, but for men's written messages. Postal service was improved, speeded up, and extended in reach. A new nation was growing up into maturity—and one of the evidences of its growth was something very like "growing pains." The time was coming when not even the railroad would provide communication swift enough to keep pace with the requirements of an economic machinery geared to high speed.

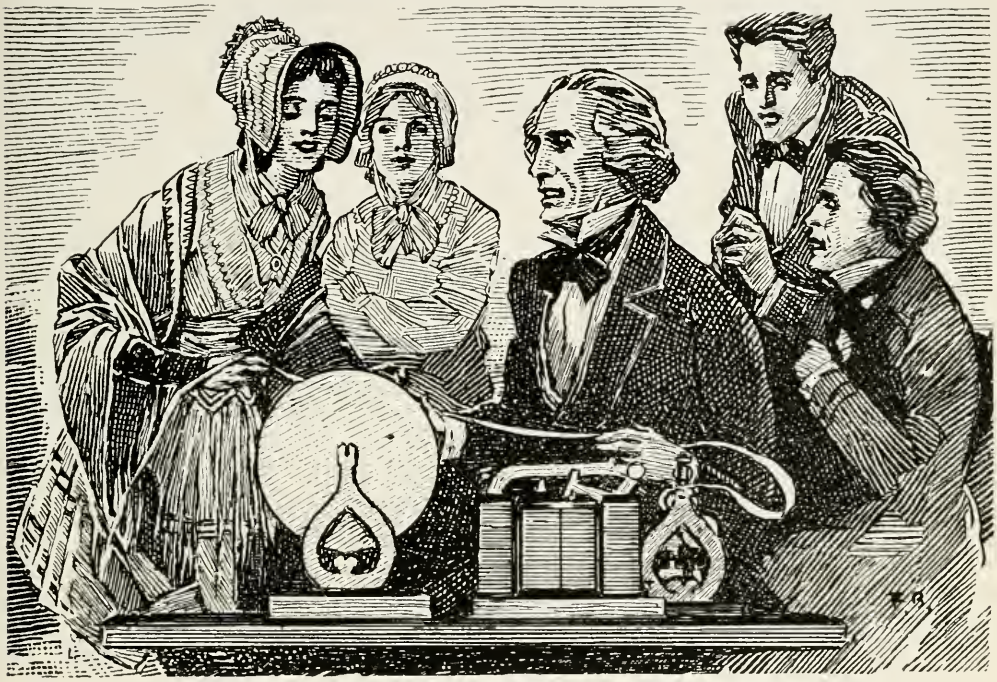
Certain social aspects there were, as well as those which were purely economic, in the nation's need for better and swifter communication facilities. To be sure, the telegraph was not, in its early stages of development, and is not now, employed extensively for social purposes—in the narrower meaning of that term. In a broader sense, it was and is a potent social factor. It permits the transmission of thought and intelligence, the interchange of ideas and opinions, which help men to understand each other better, and thus to live together more happily. It paved the way for other forms of electrical communication which even more directly form a bond between individual and individual.

The need for such a bond was beginning to become manifest when the telegraph came into being. The pioneers who made their way into unsettled regions were willing to undergo all of the privations which the conquest of the continent involved—except one. Ready enough, and even eager, to leave their homes in the East, they were not willing, if they could help themselves, to sever completely the ties which bound them to their loved ones there. Back over the trails they sent letters, borne at first by any chance messenger who could be prevailed upon to carry them. Later these informal means of communication were supplanted by others, such as the Overland Mail and the Pony Express, which in turn gave way to the first transcontinental telegraph line. They were hard-living, hard-fighting folk, these pioneers who pressed westward, but there was

in them a well defined streak of sentiment. They might but rarely use the telegraph lines as a means of keeping in touch with their relatives and friends—but it gave them a sense of satisfaction to know that the lines were there to use, if they were needed. The necessities which brought the era of electrical communication into being were, in part, social necessities.

In a democracy, economic and social relations are closely akin to those which are purely political. That the telegraph and, later, other forms of electrical communication for which it led the way, have had a bearing on the political development of the United States is so apparent that the truth need be hardly more than stated. Doubtless the United States would have had a history during the one hundred years that began on May 24, 1844, had there been no telegraph; but doubtless it would have been a far different history.

The twelve years during which Morse was working to perfect his invention and win recognition for it lay, roughly speaking, midway between two wars. The War of 1812 had quite clearly settled some questions which the Revolution had left unsolved—as, for example, the question of interference by foreign powers in the affairs of the new republic. The War between the States was to settle another question that was be-



In Washington on May 24, 1844

coming acute when the telegraph was born—the question of just what was implied by calling the American nation "a more perfect union."

BEFORE the outbreak of the second of these two conflicts, the United States was to engage in the Mexican War, which was to add vast territories to those over which the American flag was flying. The Oregon country was to become indisputably an American possession. Thousands of miles separated these newly acquired regions from the East in general and from the seat of government at Washington in particular. Distance became in a new sense a factor in the success of the American experiment in democracy. If the Union was to be preserved, and to become a still "more perfect Union," this expanse of open prairie and these towering mountains must be bridged by better and swifter communication facilities. It was no mere coincidence that the first transcontinental telegraph line was completed during the first year of the War between the States. The part played by this coast-to-coast telegraph line, and by the other facilities for nation-wide communication which followed it, in promoting the political solidarity of the United States, was one whose importance is obvious to all who know even a little of American history.

In a somewhat similar manner, the development of electrical communication facilities has been a factor of far-reaching effect in shaping the course of the relations between the United States and its neighbor nations. Global distances began to shrink when in 1866 Cyrus W. Field came to the successful end of his adventure in laying cables of telegraph wires along the bottom of the Atlantic. When to the ocean telegraph cable the wireless telegraph and the radio telephone were added, the isolation which had been provided by wide stretches of open sea was swept away, for good or for ill. Used to build a better world, these far-flung systems for the transmission of thought may play a still more important rôle in history. Whether they will help to produce a better world will depend upon the use that is made of them. Certain it is that they have already produced a smaller world.

Celebrating the Opening of an Era

IN PAYING well-earned tribute to Morse's great achievement, then, the American people are this year doing more than commemorating the invention of a piece of apparatus; they are celebrating the opening of an era. As Morse sat in Washington and ticked off the four words of this first message, he did more than write those four words, meaningful though they were. He began the writing of a new chapter in communication history, and thus a new chapter in the age-old story of human relations.

Morse's honors were well deserved, but were not won by him single-handed. There were, it is true, long periods when he had to face discouragement and defeat almost unaided. But it seems almost certain that he might never have reached final success without the encouragement of Joseph Henry; the scientific advice of Professor Leonard D. Gale, of New York University; and the technical skill of Alfred Vail. Like many other

great inventions, the telegraph was the product of coöperative effort.

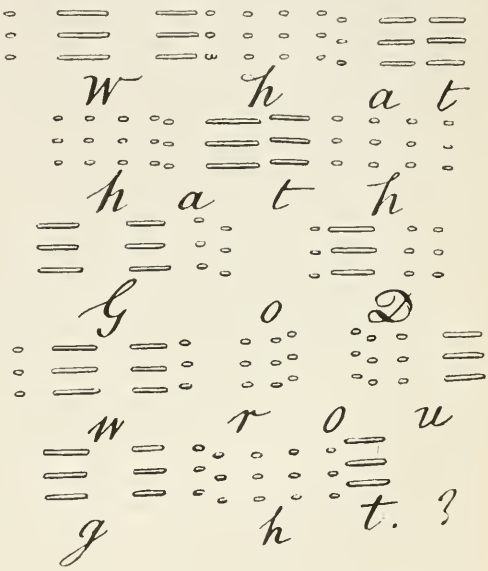
Nor was the idea of utilizing electricity for speeding men's messages new when Morse conceived his telegraph. Henry had perfected an efficient electro-magnet and, before Morse's eventful trip from Europe in 1832, had used it to ring a bell by means of a current transmitted over a considerable length of wire, which made his experimental apparatus, in effect, a potential telegraph system. Others, in Europe, notably Wheatstone and Cook in England, had developed telegraphs based on the fact that a needle can be deflected by changes in an electric current.

Nothing that was distinctly new, in itself, went into the invention of Morse's apparatus. To say which is not to detract from the greatness of his achievement. It is, rather, to pay high praise to his genius.

Artist and Inventor

It may have been not altogether an accident that the telegraph was invented, not by a physicist who had spent years in the study of electricity, but by an artist. The genius of a great artist consists less in creating new things than in combining old and familiar things in new relations. When he surpasses his fellows, he does so in the skill with which he seizes commonplaces and unites them into creations of consummate beauty. It may have been the artist in Morse that led him to see, in what other men had produced in the field of electrical research, the separate elements which might be synthesized into the telegraph; that enabled him to visualize them in new relationships.

So, too, with the invention of the alphabet which bears his name, and which many students of the telegraph have pronounced a more noteworthy contribution to communication development than the telegraph itself. Men had been making short and long marks—dots and dashes—ever since the first caveman artist had traced on a piece of bone or on the walls of his dwelling a picture of a bison or



The first telegraph message, as the receiving tape was cut and pasted in this form

some other familiar object. What the inventor of the telegraph code did was to arrange these dots and dashes in such a way as to give them new meaning. There is evidence that in working out this alphabet, Morse had a considerable amount of cooperation from Vail, as he did in perfecting his apparatus.

As with its invention, so with the commercial development of the telegraph, success was the product of the

combined efforts of many men. Mention should perhaps be made of such men as Amos Kendall, whom Morse selected in 1843 as his agent in the promotion of his invention; Ezra Cornell, later to be widely known as a philanthropist and the founder of the university that bears his name; and Henry O'Reilly, who introduced the telegraph into New England and elsewhere. These were pathfinders in the promotion of the telegraph as a business and an instrumentality of public service in the early days. Later were to appear such figures as Hiram Sibley, of the Western Union Telegraph Company, and John W. Mackay, founder of the Postal Telegraph Company, which organizations were recently merged to form a single unified telegraph system, comparable in extent and in entity with America's nation-wide telephone system.

Telegraph and Telephone

On July 26, 1874, thirty years after Morse's first telegraph message, Alexander Graham Bell explained to his father, at Brantford, Ontario, Canada, an idea he had conceived, presumably in Boston, for the electrical transmission of speech. The following year, on June 2, 1875, he verified his theory, and the first Bell telephone came from the skillful hands of his assistant, Thomas A. Watson. On March 10, 1876, the telephone transmitted its first complete sentence of speech. Somewhat less than two years later, the first commercial telephone exchange in the world was opened. A decade after the making of the first telephone, the first real step in the creation of a nation-wide system of long distance lines was taken with the organization, for that purpose, of the American Telephone and Telegraph Company.

With the growth, from these beginnings, of the nation-wide system of telephone lines which serves America today, the readers of the present article are presumably familiar. A detailed account of telephone development would have no place, even if space permitted, in a study which is devoted primarily to a discussion of Morse's great achievement, and what grew out of it.

For the telephone did not grow out of the telegraph. It was born in response to a need as urgent as that which brought the telegraph into being, but it was a different need. It was not intended to supplant the telegraph, has not done so, and seems unlikely ever to do so.

Telegraph and telephone supplement each other. Both were conceived and created in response to the needs of a nation and of a world. Both have been improved, have been made more efficient, have had their reach increased from year to year, as new conditions have made this necessary. Wireless telegraphy, which Marconi gave to the world when wire telegraphy was about a half a century old, was a new and improved form of what Morse had invented, and was brought into being to meet a new and intensified need. The radio telephone, similarly, was introduced in its first successful form to meet a need for facilities for communication by the spoken word where the use of physical circuits is impracticable.

These new needs have arisen out of the increasingly complex problems,

proceeding out of economic, social, and political growth, that were beginning to manifest themselves when Morse invented the telegraph. If some of these problems have been solved in America and in the world in any measure satisfactorily, no small part of the credit must be given to the far-reaching systems of electrical communication created during the past century. In the great problems which remain to be solved there is ground for hoping that these same communication facilities, more wisely used, will contribute importantly to their solution.

This much is clearly evident. As needs have arisen for ways of speeding more swiftly and surely men's written or spoken words, out of the workshops of solitary experimenters or the research laboratories of great communication companies have come the means of meeting these needs. Unless the spirit of the American people ceases to be what it is, the needs of the next century and those which follow it will be similarly met.

WHAT ARE Western's plans for FM? I am happy to say that we have nothing new to show you now and nothing new to talk about. I am happy because I do not have to tell a soldier named Joe, who needed a radio very badly last month, that we could not deliver it because we diverted some engineers and some shop people to building the model of a new super-dooper FM equipment to show you and thus strengthen our post-war position. I am sorry that I can't tell you when we will be able to talk. But then, no one can tell me when the war will be over.

From an address by F. R. Lack, Vice President, Western Electric Co., before a meeting of FM Broadcasters, Inc.

READERS of the Winter issue of this MAGAZINE who recall the article "Information about 'Information,'" and particularly the references to reducing the number of unnecessary calls to Information operators, may enjoy the following bit of dialogue from a recent "Duffy's Tavern" broadcast:

Colonel Stoopnagle—"Hello, Information, I'd like the phone number of Duffy's Tavern. . . ."

Archie—"But, Colonel, *this* is Duffy's Tavern!"

Stoopnagle—"Oh, really? What's the phone number?"

Archie—"It's Orchard 2–9970."

Stoopnagle—"Thank you. Hello, Information, that number is Orchard 2–9970. . . . You're welcome. . . . In the future, look it up in your directory."

The U. S. Army Is the Only Combatant Force Making Use of Frequency Modulation in Its Tactical Radio Sets in Armored Divisions and Field Artillery

Radio Telephones Guide the "Blitz Buggies"

Vance Hilliard

It is *D Day*—the day of the Allied invasion. The time is *H Hour plus 30*, or 30 minutes after the beginning of the powerful amphibious assault. In the second wave of landing craft to reach shore—*any* shore—is one which carries a particularly valuable cargo—a special radio car with olive-green paint and the white star of the U. S. Army on its sides. As the gate of the assault boat clatters down, the car moves into hub-deep water and across the beach to a place of concealment. Projecting above it is a slender antenna and in the rear seat is a new type of frequency modulated (FM) radio transmitter and receiver set.

As the car comes to a stop, the soldier seated at the radio begins to speak into the mouthpiece of the transmitter a succession of messages which may sound something like this: *"Mary-M to Kenneth . . . ready at B . . . will make contacts"; "Mary-M calling Green . . . in position . . . report . . . over"*; and *"Mary-M relay to Kenneth . . . relay from Green . . . no opposition at four-dash-six . . . no opposition at four-dash-six."* As each message ends, the operator stops only long enough to depress one of the push buttons on the radio panel in front of him before resuming his cryptic phrases.

Soon this spot and others along the coast are lined with landing craft of every description. From them pour tanks, scout cars, personnel carriers, and motorized artillery which form quickly into groups on the beach and then head inland on their invasion missions. With each attacking force is at least one FM radio, and each set is adjusted to a different frequency to eliminate interference.

The groups of vehicles are soon widely scattered, but the plan of attack—timed to the split second—is carried out on schedule. As objectives are reached and won, command-

ing officers make their reports and receive further orders by radio. Focus of all these messages is "Mary-M"—which may be the code name for the small radio station in the car at the beach. Using his FM transmitter-receiver as a relay station, the operator receives messages from the various forces inland and re-transmits them to invasion headquarters in a ship off-shore. When a group runs into unexpected opposition, "Mary-M" relays the information to others in the vicinity. When a landing beach is cleared, the signal is passed on by radio to the landing boats awaiting their turn.

As the invasion gathers momentum, messages come thick and fast, but the operator is able to shuttle them back and forth without losing a second of valuable time. His new combat radio equipment requires no manual tuning or hairline adjustments. It is operated by pushing buttons—not by turning dials and knobs—and it works almost automatically after the power is turned on. The set he is using is the "brain child" of engineers at the Bell Telephone Laboratories, designed by them in coöperation with the U. S. Army Signal Corps, and manufactured by the Western Electric Company.

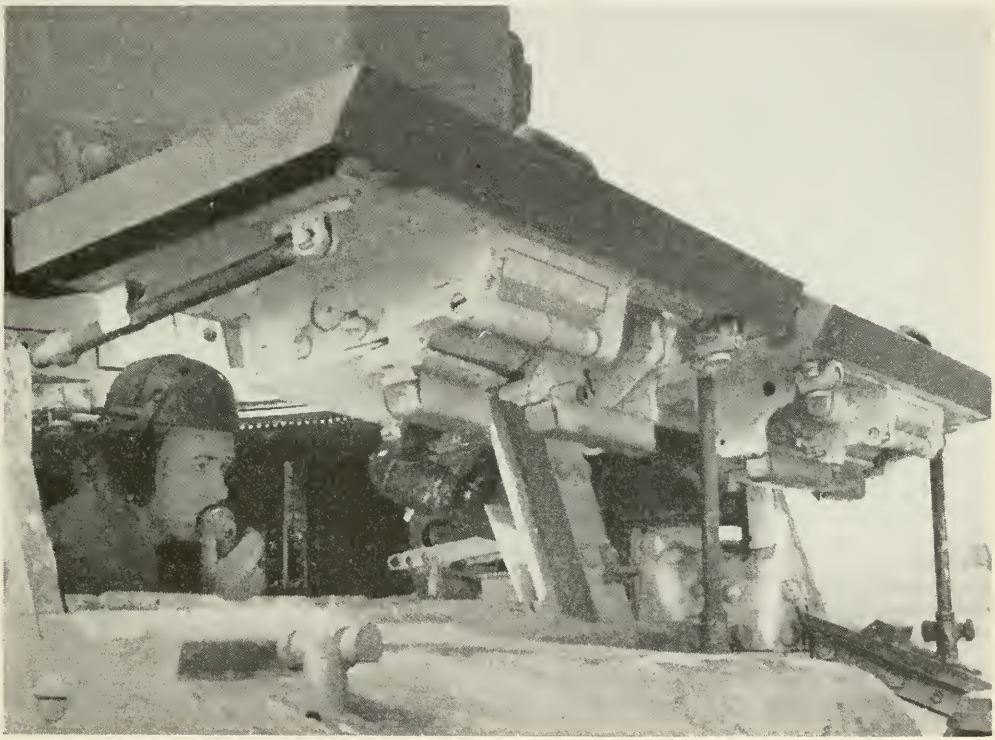


PHOTO BY U. S. ARMY SIGNAL CORPS

SOME OF THE radio telephone equipment which provides this American light tank's communications is faintly visible in the interior behind the driver

This radio equipment received its baptism under fire as described above at the Allied invasion of North Africa. Since that time it has been employed in the same way at our landings on the Sicilian beaches, at Salerno and Anzio in Italy, and in the South Pacific. When the long-awaited attack on "Fortress Europe" is a reality, the story will be repeated again and this new radio equipment will play an even more important part in coördinating the movements of our armored spearheads in their drive toward the heart of the enemy.*

"Gabriel" Under Fire

THE FIRST TYPE of FM combat radio developed by Bell Laboratories was the tank set. Later a slightly different unit, the FM field artillery set, was designed for that branch. The names are misleading, however, as both types of equipment are used throughout the armored divisions and field artillery in tanks, halftracks, tank destroyers, and command cars. Together they account for a sizeable percentage of all radio equipment installed in the vehicles of the U. S. Army—the only army in the world using frequency modulation in its tactical radio sets, according to the Signal Corps.

An indication of how a tank crew uses its radio when under fire can be gained from the story of a pitched tank battle reported from North Africa by a foreign correspondent for *Collier's* magazine.

A General Sherman tank, dubbed "Gabriel" by its crew, was on the extreme flank covering a withdrawal of our forces before Sbeitla. Exposed to German fire on three sides, its position was wholly unenviable. "Rusty" Fugate, Gabriel's commander, perched in the turret, saw dust in the distance. Then he saw tanks—Jerry tanks with five bogey wheels. He pushed a button on the radio transmitter beside him to get the frequency of the company commander's tank, and reported to Captain George Johnson that there were twenty enemy tanks in sight, more coming, and three had turned off to flank Gabriel's position.

"When do I fire, sir?" asked Fugate.

"Wait till they get even with you," said Johnson, "then pour it on."

The three German Mark IV's continued on their way, oblivious to Gabriel, then a good half-mile away. As they came parallel on the left, "Slim" Davis, the gunner, let them have it with his 75-mm. cannon. The resultant black explosion was 'way beyond the target. Frantic with fear that the quarry might escape, Slim made a correction for range and the next burst was right over the leading enemy tank. It disappeared in a mass of flames. The second shot accounted for another of the trio. The remaining tank was now backing off hastily and Slim's gun was tracking. A third shot—and a third blinding flash marked another hit!

WITH HIS RADIO on company frequency, Fugate reported, "We got all three, sir." Then, as he saw the third tank crawl painfully rearward, he added, disgustedly, "As you were! Only two, sir. One is getting away." Forgetting to switch his set from the transmitting position, and believing he was talking over the tank interphone system, he yelled at Slim for

* As this issue goes to press, the Allied invasion is still in preparation and not an actuality.

all to hear, "Are you gonna make a liar out of me now?"

Slim continued firing and explosions burst all around the crippled and retreating tank. After another blinding flash it flopped into a wadi and disappeared.

Then it came! Fugate heard a whistle and a scream, and ducked into the turret just as a shell exploded near Gabriel's stern. Still forgetting he was on the transmitting position, he shouted, "There goes home and Mother!"

The shell had just missed a direct hit and the tank was badly shaken. Looking around, Fugate saw that the main encounter between his buddies and the group of 37 German tanks had passed out of sight and Gabriel was all alone. Making contact with Captain Johnson again, he asked for orders, and was instructed to retreat slowly in a certain direction.

Gabriel found cover and limped back to join the others. On the trip home the company accounted for several German 88-mm. guns. A small explosive shell nicked Gabriel's rear sprocket, and 20-mm. machine gun slugs beat against its armor plate. Finally the company of tanks got through and crawled wearily to an olive grove in the rear.

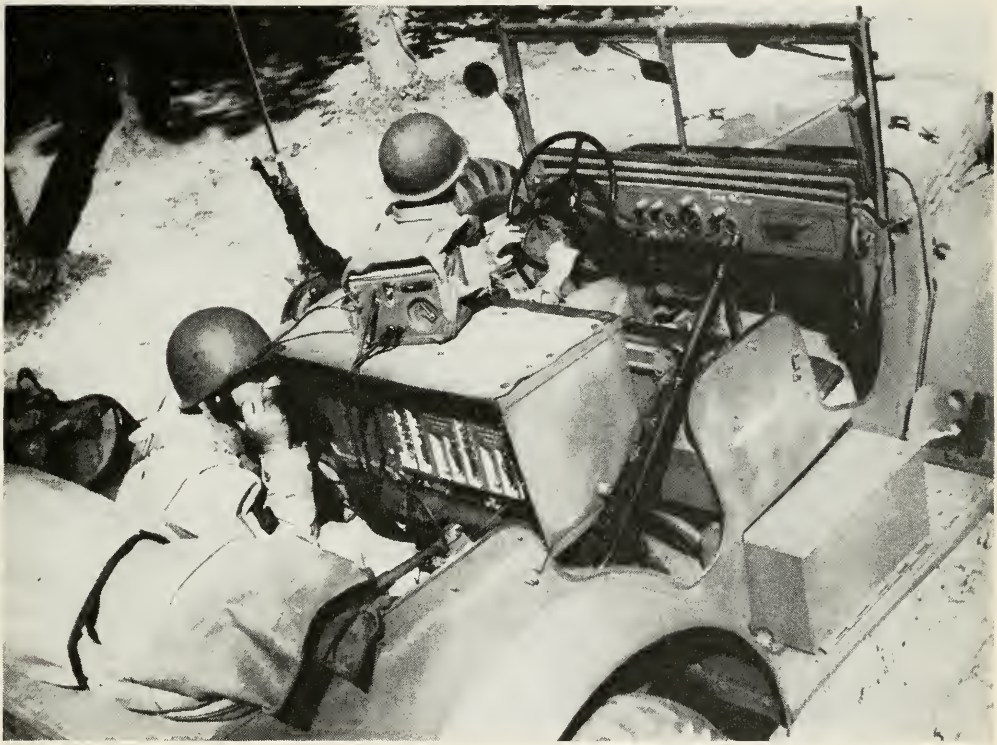


PHOTO BY U. S. ARMY SIGNAL CORPS

FIELD ARTILLERY SETS, such as the one installed in this command car, link forward observers with batteries in the rear

The Radio Network

RADIO COMMUNICATION is to our armored divisions what the telephone is to the infantry. In the latter branch, each field army has its own vast telephone system which reaches, principally by wire, from front line observers through numerous field command posts all the way to general staff headquarters. In every armored unit a radio network similarly speeds combat information from the most advanced platoon—smallest unit in this command—back as far as corps headquarters.

The platoon leader, with several tanks under his direction, has both an FM transmitter and an FM receiver, while other tanks in the platoon may have receivers only. Several platoon leaders report to a company commander, who usually has a transmitter and two receivers in his tank.

Company commanders, in turn, report by radio to the battalion commander, whose "office" in the field is a halftrack motor vehicle. He has two complete radio sets: one for FM radio telephone communication and another for code transmission. With these he issues orders to the battalion's service units, mortar platoon, and mobile artillery, and makes his reports to the divisional commander above him.

Divisional headquarters, further to the rear, is the highest echelon of the armored command. Here the divisional commander—usually a major general—uses radio to direct the hundreds of tanks and cars in his armored group. He has the same two types of radio equipment used at battalion headquarters, and with these he receives messages from the battalion heads, and transmits commands to the division's artillery, reconnaissance units, and supply and maintenance services. Over the FM radio telephone he reports to the corps commander above him, who directs all the ground fighting in the area.

This effective communications system is built around Western Electric's FM radios, which form a major part of the 975 sets used by an armored division. The U. S. Army now has thousands of tanks in action and many thousands more in reserve, *and nearly every one of these carries radio equipment furnished by the Western Electric Company.*

THE FIELD ARTILLERY—a branch of our forces respected and feared by every German and Jap fighter—employs FM radio as an important part of its fire control system. Ranging far ahead of every rifle and howitzer battery is an observer—usually the only member of the artillery team to see the target on which the guns are trained. Through the radio in his scout car he sends back information on the location and range of the enemy-held objective. Battery computors convert this data into degrees of azimuth and elevation, and pass it along to the gun crews by telephone. The first "ranging" shots are usually wide of the mark but in a matter of seconds the corrections radioed from the observer put the battery "on target." Then it is often only a matter of loading and firing until the target is destroyed.

German and Jap prisoners taken by American troops have repeatedly admitted our artillery fire to be the most accurate and concentrated they

have ever seen. Training, equipment, and dependable communications have all helped our gun crews establish this enviable reputation.

Two Types of Radios

THE VEHICULAR RADIOS Western Electric has been producing under Signal Corps contracts since October, 1941, are of two general types. The original set was the tank set, now issued to both armored forces and artillery. The use intended for the vehicle determines whether its radio equipment consists of a receiver alone, a transmitter and receiver, or a transmitter with two receivers. When only a receiver is used, a special amplifier is necessary for the tank's interphone system. In a medium tank the set is installed in the gun turret; in a light tank it is generally placed in the sponson near the driver.

On the control panel of each transmitter and receiver are ten push buttons, which take the place of the usual calibrated tuning dials. These represent ten different radio frequencies or "wave lengths," and are used for the same purpose as the push buttons found on some home radios. By depressing one of these buttons, the operator automatically "tunes" the transmitter or receiver to the frequency desired—and in a fraction of a second he can change the frequency and talk on a different radio channel.

Behind a cover on the front of the transmitter are ten small quartz wafers, each enclosed in a plastic case. These crystals determine the exact frequencies on which the set will operate, and keep it from interfering with other transmitters. A drawer in the cabinet contains 70 additional crystals, each one made for a different radio frequency. By plugging in any ten of these in the crystal compartment, the transmission band is changed completely.

A special mounting which holds the transmitter and receivers and secures them to the tank chassis is more important to the successful operation of the set than its appearance indicates. In a moving tank, lunging and bucking over rough ground and leveling trees as large as telephone poles, even the crew must wear helmets and heavy padding to avoid injury. An unpro-

TEN OF THESE tiny quartz crystals operate in each FM radio. In each tank set 70 more, and in each artillery set 110 more, are available to change bands

tected radio set would be quickly damaged, no matter how strong its parts and connections. The mounting which is used was designed by the Bell Laboratories and is furnished by Western Electric as a part of the equipment. With the help of a leading rubber company, a special absorbent pad was developed which provides the necessary protection and is unaffected by extreme temperatures. Used between the set and the tank frame, these prevent shocks and vibration from reaching the radio apparatus. To discover just how much punishment the radio and mounting can take, the Army conducted a test which subjected a medium tank to numerous hits from a 75-mm. anti-tank gun. Several of the powerful shells exploded within a few feet of the radio equipment, but when the set was tested, it performed as though nothing had happened.

To provide communication within the tank, each crewman has a microphone, a headset, and an interphone control box for switching from one line to another. The interphone system is part of the radio equipment, and amplification is secured through the radio transmitter. In the past the hand-held microphone has been used for both interphone and radio transmission, but many crews now prefer the throat and lip "mikes," which leave both hands free for driving and fighting.

SECOND of the two types of Western Electric vehicular radios is the field artillery set, a slight modification of the original tank set. It operates on a somewhat higher frequency band and has 120 crystals instead of the 80 in the tank set. It is used throughout the field artillery by battery observers and for general communications. To meet special conditions it has been installed in many tanks. Because its frequency band overlaps the band used by the tank set, the two may be adjusted for intercommunication.

Radio and telephone communications in the U. S. Army has made rapid strides in the nearly five years since Hitler raised the curtain on World War II. In no branch is the advance more marked than in the armored forces or the artillery, whose latest vehicular radios have just been described. Much of the credit for these powerful communication weapons belongs to the scientists and engineers of the Bell Telephone Laboratories who conceived and developed the original design, and to the men and women of Western Electric who have manufactured them in quantity. Here is the story of how these two groups coöperated to produce a new and better type of combat radio.

The Signal Corps Program

SEVERAL YEARS before our entry into war, the Signal Corps initiated a development program which has given our fighting men a communication system—and communication equipment—second to none. In the latter part of 1940, Bell Laboratories was handed one of the toughest development jobs on the list—vehicular radios for tanks and motorized equipment. The Signal Corps knew in general what it wanted in this equipment, but it placed on the shoulders of the Laboratories' people the responsibility for creating an entirely new type of mobile radio: one that could take the terrific abuses of tank

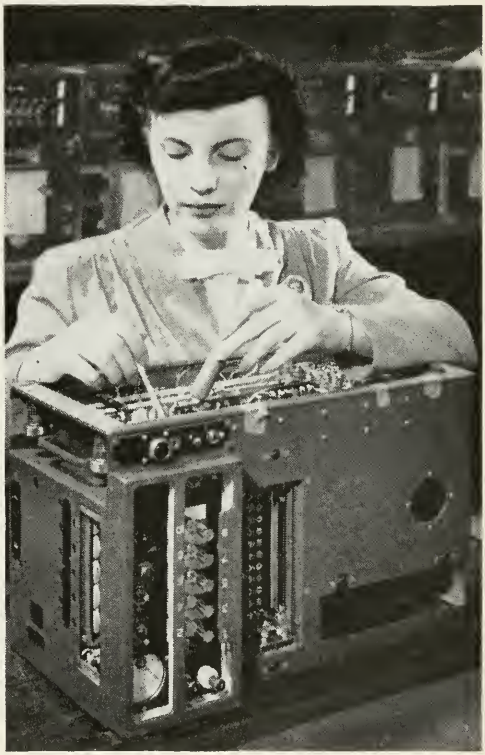
warfare in its stride and still transmit clear, intelligible voice messages with little or no attention from the operator. To insure prompt contact between stations, it was decided to use quartz crystals for controlling the set's many frequencies instead of relying on tuned electrical circuits. With some apprehension the Laboratories accepted the job, and a time schedule was set which made the engineers involved shudder.

AM vs. FM

FIRST EFFORTS were directed toward the design of a conventional amplitude modulated set. Then it was decided to change the design to one of frequency modulation in order to reduce natural and man-made static and to improve the operation and range of the equipment. The original AM design was continued, however, so that comparative tests of the two could be made.

Because so much depended on its outcome, quartz crystal research was given emphasis and Laboratories' engineers worked with production specialists of Western Electric on the problems involved in mass-producing these precise little pieces of quartz. When the final designs were tested and found satisfactory on every count, one of the most difficult problems had been solved.

As the job progressed, countless rough sketches of circuits and layouts were made. The best of these were selected by laboratory tests and complicated mathematical procedures, and hundreds of working drawings and schematics were prepared. Mechanical engineers were called in, for this "tank set" had to be a mechanical masterpiece, with a multitude of gears, cams, and moving parts. Materials engineers did their part by devising alternatives to replace the aluminum and copper which it was then recognized would become scarce, and by fitting the set for the rough handling and extremes of temperature it would have to undergo. The Signal Corps aided in the development by conducting numerous tests and checking the Laboratories' results. Hand-made models of both transmitter and receiver were completed and given a final laboratory check. In normal times, at least a year would have been



A TANK SET gets an inspection at Western Electric's Hawthorne Works. This is one of many tests given before the equipment is turned over to the Signal Corps

required for so complex a job as this. Actually, it was only *three months* from the time the Signal Corps made its request to the Laboratories until the first hand-made FM set was completed.

Passing the Tests

THE FIRST field test of the finished equipment was made by the Laboratories' engineers alone. Taking the new transmitter and receiver some distance outside New York, they put them through their paces—and the results were gratifying. Next the equipment was taken to Fort Monmouth, where it was tested and approved by the Signal Corps. The last and severest test was at Fort Knox, a headquarters camp for armored units. There the set was installed in a tank and put through a stiff road test, to see if it could "take it." It could—and did! Then quality of reception and range of the Laboratories' set were compared with two sets designed by other organizations. The Laboratories' set won "hands down." Next an enlisted man with no previous experience as a radio operator was given a few minutes' instruction and then turned loose alone with the equipment to send and receive a series of messages. He encountered no difficulty in any of the operations.

There was no question about the set being accepted by the armored command. It had performed so well that the officers accepted it without making a single major change. It was a good radio, but the army needed thousands of sets instead of just one—and in a hurry. Production in quantity was Western Electric's responsibility.

Western Electric wasted no time in getting the set into production. Even before a contract was received the job got under way at Hawthorne, where work was started on 100 sets. Some of these had already been completed when the first army contract for thousands of transmitters, receivers, and mountings was signed.

Even under pressure, tooling for a job of this size takes a lot of time, but the army could not wait. It set October 31, 1941, as the date for delivery of the first five production sets. This allowed but six months for securing machines and tools, training hundreds of men and women for the exacting work, procuring raw materials, and setting up complicated testing procedures. More than fifty Hawthorne engineers were assigned to the project and work went on day and night, with Bell Laboratories' men on hand to help when they were needed.

Problems in Quartz

AMONG THE many production problems encountered—and solved—were those in crystal manufacture. To save quartz, the crystals had been designed as small as possible, with the result that a half-dozen will fit on a postage stamp without overlapping. These had to be finished to microscopic accuracy, then the faces silver-plated and the connecting wires and mount attached. Soldering irons were too slow and clumsy, so tiny jigs were designed to hold the elements while a minute drop of solder is melted on each face of the wafer by a blast of hot air.

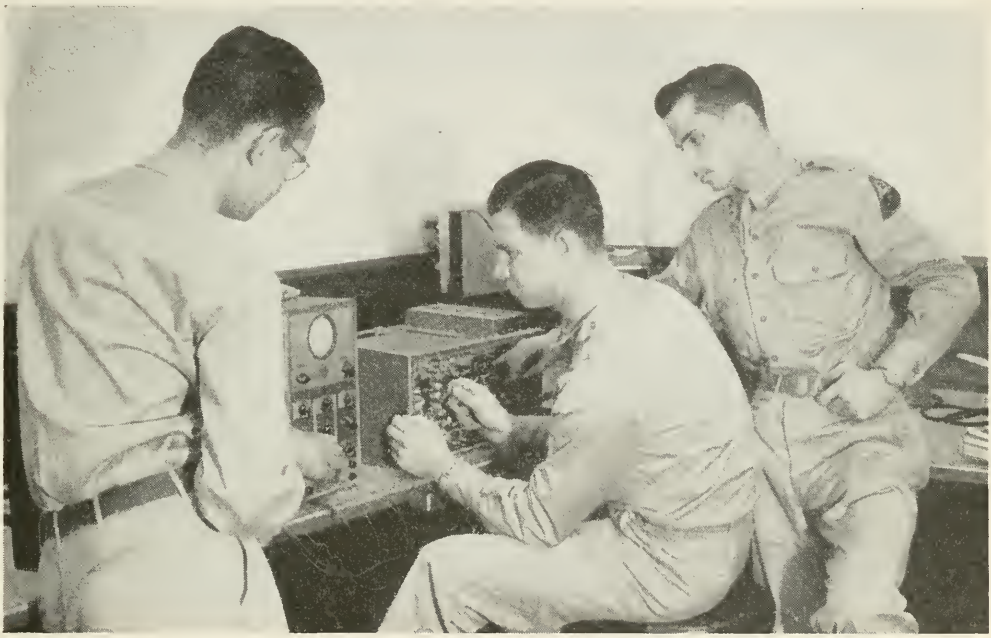
Although temperature control of the crystals is provided in the transmitter by heating coils and a thermo-

stat in the crystal compartment, it was the aim from the first to make the crystals themselves immune to extremes of heat and cold. This aim is reflected in one of the tests given the finished crystals, which subjects them to temperatures of —40° F. in a dry ice compartment and + 158° F. in a heat chamber. If the frequency of the crystal under test varies by more than .02 per cent, it is rejected.

The first production goal was reached by the October 31st deadline, when the five sets requested by the army were delivered. Five weeks later, when the Japanese attack drew us into war, the army's vehicular radio sets were leaving Hawthorne in quantity.

As America's war industries expanded, shortages of raw materials called for ingenuity in redesigning numerous parts of the equipment without slowing up the program. In spite of this and other manufacturing "headaches," every contract has been completed on schedule. The quantity delivered by Western Electric during the past two-and-one-half years is not for publication, but the total number is enormous. Our "blitz buggies" have not had to wait for their radio equipment.

From the beginning, some of each of the principal component units have been subcontracted to several selected manufacturers, and with the assistance of Western Electric engineers



Soldier students at the Bell Telephone Laboratories School for War Training run a test on the tank radio as part of their training in repair and maintenance of this equipment

these subcontractors reached a point where they could handle the entire load. In 1943, with production running smoothly at Hawthorne, it was decided that the Western should concentrate its efforts on other, more critical electronic items for the Army and Navy, and the manufacturing job for vehicular radios was shifted to the established subcontractors. At present, Western Electric serves as a prime contractor, furnishing a few of the more critical items and with the responsibility of assuring the quality of every set before it is turned over to the Signal Corps.

The Bell Telephone Laboratories School for War Training has given valuable assistance to the Signal Corps by providing instruction for many of the technicians needed to repair and maintain the vehicular radio equipment. More than 300 army personnel—officers and enlisted men—have attended the school in New York to learn the principles of frequency modulation and the circuits and operation of these particular sets. After receiving five weeks of intensive training, they have been sent to army camps in this country and overseas to work in repair depots and instruct other groups.

When the war is over and all combat information has been compiled and analyzed, the FM tank and artillery radios developed and produced by the research laboratories and the manufacturing arm of the Bell System will certainly be recognized as having contributed materially to the success of our land offensives.

Who's Who & What's What

(*Continued from page 3*)

lately, "The American Telephone Historical Library: 20 Years of Service," in the Magazine for November, 1942. The portrait of Morse on page 45 is reproduced from "Samuel F. B. Morse: Letters and Journals," through the courtesy of Houghton Mifflin Company, publishers.

Vance Hilliard

Having majored in advertising and marketing in college, Vance Hilliard's first business experience was, quite naturally, with a New York advertising agency, where he wrote advertising copy for industrial clients and assisted in the editing of a monthly magazine for printers. From this work he went to a manufacturer of heavy machinery, where he had charge of writing and producing sales bulletins and catalogues. He joined the Public Relations Department of the Western Electric Company in 1941 as a writer of advertising and publicity copy.

Aid to Victory

Two years of war have tested the Bell System's character and its capacity to serve the nation. Good telephone service is vital to victory and events have demanded the utmost efforts to insure that every war telephone need be met. The results have contributed to the extraordinary accomplishments of American industry and the progress of our fighting forces all over the world. Ships, planes, tanks and guns have been produced in vast quantities and men trained and equipped to win victories, with a speed which would hardly have been possible without swift and plentiful telephone communication.

The war achievement of America is based on the heritage of freedom that America is waging war to preserve. The things we are fighting for are the things that will enable us to win. Our system of freedom of private enterprise has outmatched the productive accomplishments of every other country in the world, and our telephone service meets the requirements of American industry, and heightens its pace, because the telephone industry itself has had the stimulus of freedom.

Imagination and initiative, thus encouraged, have created the incomparable communications plant of the Bell System and have brought about steady progress in the telephone art. Telephone men and women have learned to work skillfully together as a team; abilities of individuals have been recognized and supervisory and management positions have been filled from the ranks. This policy has built up the collective experience necessary to meet the emergency of war and to train the great numbers of younger people now serving in the Bell Telephone Army on the home front. The System has been able to expand its service because over the years it has been permitted, under regulation, to earn enough money to pay good wages and also to pay a reasonable return on the savings invested in the business, sufficient to attract the new capital needed to meet growing demands.

Above all, the complement of freedom is the sense of responsibility which telephone people call the spirit of service. In this war the spirit of service is the spirit of victory, and the men and women of the Bell System, in whom this spirit lives, may be relied on to do their utmost.

From the A. T. & T. Annual Report for 1943.

Financially, the Bell System has not profited by the war. Earnings on investment have, except for the recent depression years, been the lowest on record, a period of more than forty years, and, in spite of a record-breaking volume of business, earnings for each of the past two years have, in percentage of revenue, been lower than in any previous year, not excepting the lowest of the depression years. Although the price of practically everything has increased, telephone rates have not increased:—on the contrary, long distance telephone rates have been reduced substantially. The schedules of pay of Bell System employees are the highest they have ever been.

Financially, the Bell System, while not itself profiting by the war, has contributed very substantially to the war effort. Since Pearl Harbor, the System has paid in taxes to the Federal Government more than $648,000,000, or nearly two-thirds of a billion dollars. Over $300,000,000 additional has been collected by Bell System companies and paid to the Federal Government in excise taxes borne directly by telephone users. Thus, about a billion dollars of the cost of the war has been paid directly and indirectly by the Bell System and its telephone customers. Moreover, the System has coöperated in each of the four War Loan campaigns and has kept practically all of its cash assets invested in Government securities. Also, some $200,000,000 of United States War Savings Bonds have been purchased by Bell System employees through payroll savings plans and in War Loan campaigns.

From President Walter S. Gifford's statement to A. T. & T. stockholders at the Annual Meeting on April 19,

For the Record

A selected list of happenings, of System interest, occurring between January 1 and April 30, 1944

TELEPHONE conservation order U-2 and preference rating order U-3 were slightly amended by WPB on January 20, the changes being in the direction of greater flexibility. On March 18 telephone limitation order U-8, a revision of order L-204, became effective, affecting the purchase of telephone parts and relaxing somewhat restrictions on production of special types of telephones. U-3 was further amended on March 15 and U-8 on April 7.

Assistant Secretary of State Adolf A. Berle was appointed to the Board of War Communications on February 1, succeeding Assistant Secretary of State Breckenridge Long. In preparation for the invasion of western Europe, BWC established on April 13 the offices of traffic coördinator and assistant traffic coördinator, naming to the former post Commander Franz O. Willenbucher, U.S.N., and to the latter Marion H. Woodward of the staff of the FCC.

Chief Engineer E. K. Jett of the FCC became a member of the Commission on February 15. He was succeeded as Chief Engineer by George P. Adair, who had been Assistant Chief Engineer in charge of broadcasting.

The Associated Companies of the Bell System filed tariffs with the FCC, effective February 15, to prohibit the collection by hotels, apartment houses, and clubs of surcharges on interstate and foreign long distance telephone messages. At the same time, the companies agreed to pay 15 per cent commissions to hotels, apartment houses, and clubs on charges for such messages from guest rooms.

Radio telephone service was officially opened between the United States and Trinidad, B. W. I., on February 23. On April 27 it was announced that restrictions on personal radio telephone calls between the U. S. and the Bahamas, Jamaica, and Trinidad were lifted and that important business as well as government calls between the U. S. and Bermuda may now be made.

In a letter to President Niles Trammel of the National Broadcasting Company dated February 29, Vice President K. S. McHugh of A. T. & T. Co. pointed out that the Bell System's planned construction of several thousand miles of coaxial cable within the next five years may form the basis of a nation-wide television network. On March 16 the A. T. & T. Co. announced its plans for the trial of short-wave relay radio between New York and Boston as a means of supplementing present long distance telephone facilities and of transmitting television programs.

Beginning on March 1, night message toll telephone rates became effective at 6 P. M. instead of 7 P. M. A reduction in overtime rates on most teletypewriter exchange service took effect at the same time. The former was expected to result in an annual reduction of about $8,250,000 and the latter about $2,450,000.

On April 1 the "anti-slug" bill, which makes the manufacture or sale of slugs for fraudulent purposes a felony, became federal law.

The annual meeting of stockholders of the A. T. & T. Co. was held on April 19. All 18 directors were re-elected.

The granting of the National Security Award, established to "recognize superior organization for plant protection and security," to all of the operating companies of the Bell System, including the Long Lines Department, was announced on April 20 by the U. S. Office of Civilian Defense.

ume XXIII Number Two Summer 1944

Bell Telephone MAGAZINE

Public Library Kansas City, Mo.

phones Are in the Fight on Every Battleground • MAJOR GENERAL HARRY C. INGLES

The Bell System's Safety Observation Plan • ERLE S. MINER

We Don't Like to Say "No" • JOHN W. ORD

Recreation Facilities for Bell System Women • RAYMOND A. STEELMAN

When a Circus Burns • RAYMOND A. LORING

nerican Telephone & Telegraph Company · New York

Bell Telephone *Magazine*

Summer 1944

Telephones Are in the Fight on Every Battleground, *Major General Harry C. Ingles,* 69

The Bell System's Safety Observation Plan, *Erle S. Miner,* 93

We Don't Like to Say "No," *John W. Ord,* 103

Recreation Facilities for Bell System Women, *Raymond A. Steelman,* 114

When a Circus Burns, *Raymond A. Loring,* 125

"Electronics—Today and Tomorrow" (a book review), *Harold S. Osborne,* 128

Sound Movies for Sound Education, 129

For the Record, 132

"The ideal and aim of the American Telephone and Telegraph Company and its Associated Companies is a telephone service for the nation, free, so far as humanly possible, from imperfections, errors, or delays, and enabling anyone anywhere to pick up a telephone and talk to anyone else anywhere else, clearly, quickly and at a reasonable cost."

A Medium of Suggestion & a Record of Progress

Published for the supervisory forces of the Bell System by the Information Department of American Telephone and Telegraph Co., *195 Broadway, New York 7, N. Y.*
Walter S. Gifford, *President;* Robert H. Strahan, *Secretary;* Donald R. Belcher, *Treasurer*

Who's Who & What's What *in This Issue*

As between a "GI Joe" observing from a foxhole, with a telephone for company and field wire his only link with the command post, and the Chief Signal Officer of the Army, both of whom have an intense comprehension of the importance of communications in battle, the former has doubtless a more directly personal interest in them —but the latter has the broader, the world-wide view. So we are happy indeed to have the name of Major General Harry C. Ingles at the head of the list of contributors to this issue. Graduated from West Point in 1914, he is a Signal Corps officer who in recent years has been a member of the General Staff of the War Department; G-3 of the Caribbean Defense Command and later Chief of Staff of that Command; and Commander of the Mobile Ground Forces of the Panama Canal Department. He went overseas in 1942, and later became Deputy Commander of the United States Forces in the European theater of operations. He was appointed Chief Signal Officer, A. U. S., on July 1, 1943.

Various assignments in the plant department of the Southwestern Bell Telephone Company, including central-office repairman, division plant engineer, general plant installation supervisor, and general plant training supervisor, occupied Erle Miner from 1922 to 1929. This experience gave him a first-hand view of the System's training and safety programs from both the practical and the administrative standpoints. In 1929 he was transferred to the Department of Operation and Engineering of A. T. & T., to work on plant training problems, and in 1937 he became safety engineer—the position he now holds. His most recent previous contribution to this Magazine was "First Aid Training in the Bell System," published in the issue of November, 1942.

The name of John at the head of Mr. Ord's article will appear strange to the

Maj. Gen. H. C. Ingles

Erle S. Miner

John W. Ord

Raymond A. Steelman

Raymond A. Loring

host of his System friends who know him only as JACK. Like many another versatile telephone man, he has had experience in both commercial and traffic departments; but, unlike most Bell System people, he was born in England, and began his telephone career, in 1913, with the Bell Telephone Company of Canada. There he progressed, with an interlude of five years out for war, until he came to the A. T. & T. Company in 1926. Since then he has been, in the Commercial Division of the O. & E. Department, an engineer; general commercial problems engineer; sales engineer—in the days when sales were something to be sought and not to be avoided; and, since the beginning of 1942, commercial results engineer.

WAR HAS PLACED special emphasis on certain phases of the telephone job which might not seem, at first glance, to be particularly affected. RAY STEELMAN felt that his story could best be highlighted by pictures, and so has provided more pages of photographs than of text—a reversal of the usual space proportions which is also evident in the first article of this issue. From 1916 to 1922 he was in charge of employees' dining service in Philadelphia for the Bell Telephone Company of Pennsylvania. Since that time he has been in the traffic division of A. T. & T. Company's O. & E. Department, and closely concerned with—among other matters—the maintenance of the various types of quarters he discusses. He was the author of "War-Time in the Traffic Departments," in the MAGAZINE for August, 1942.

THE MORE DISASTROUS or the more horrible a catastrophe may be, the greater is the need for fast and reliable communications: to call for help, to alleviate suffering, to bring reassurance—and the greater too is the test of the telephone organization, and the opportunity for telephone people to perform helpful services. Had the circus "big top" burned in any other city, the response of telephone men and women there would have been much the same—since the spirit of service is the common possession of them all. But it happened in Hartford, and so it is RAYMOND A. LORING, general information manager of the Southern New England Telephone Company, who tells the tragic story in this issue. His training and experience as newspaper reporter and editor in Springfield, Providence, and New Haven, before he joined the Southern New England Company in 1931, are reflected in the vivid phrases of his narrative.

The

Chief Signal Officer

ARMY OF THE UNITED STATES

Extends His Appreciation

to

American Telephone and Telegraph Co.

For loyal and patriotic services rendered the Signal Corps of the Army of the United States in the accomplishment of its vital mission during a period of national emergency.

This acknowledgment of your distinguished contribution in furtherance of a future world at peace will be inscribed forever in the annals of the Signal Corps.

Issued at the City of Washington, this first day of June, in the year of our Lord one thousand nine hundred and forty four.

Attest:

Colonel, Signal Corps,
Executive.

Major General,
Chief Signal Officer.

Reg. No. 2

This is a reproduction in reduced size of the "Certificate of Appreciation" which Major General Harry C. Ingles, Chief Signal Officer, A. U. S., presented to the American Telephone and Telegraph Company on June 23. For a quotation of part of the General's remarks on that occasion, see page 71.

In All Theaters of Operation, Wire and Radio Communication and the Men Who Install and Maintain It Help to Coördinate the Army's Tremendous Striking Power

Telephones Are in the Fight on Every Battleground

Major General Harry C. Ingles

Chief Signal Officer, U. S. Army

THE MODERN TELEPHONE, whether using wire lines or radio waves to transmit its messages, has helped to give our combat forces in this war a coördinated striking power never before approached by this or any other nation.

In the forward battle areas with American fighting men around the globe, the telephone—long taken for granted in the every-day life of our people—is a powerful weapon of both attack and defense. Back of the lines, too, at regimental, division, and general headquarters and on to the Commander-in-Chief, millions of telephones speed the messages of war over lines which knit the whole mighty effort together into a pattern for victory.

Let us examine here the job the telephone and the other instruments of rapid communication are doing as front-line combatants, and see how they are performing out there where the bullets and shells and bombs measure a man's life in minutes or seconds—minutes or seconds in which a field telephone and a few hundred yards of assault wire may spell the difference between life and death for the men who face the enemy.

It is too soon after the invasion of Normandy, as this is written, to be able to cite specific instances of the incalculable importance of quick communications in that vast and hazardous and complicated operation. But what part they are playing in the major assault upon "Fortress Europe" may be inferred without difficulty both from news stories of our progress there and from what can be told of earlier actions and successes.

TELEPHONE CABLE, telephone wire, telephone poles stored in England in anticipation of the invasion await transportation to the Continent

FRANCE

LEFT: Beach master, with microphone and loud speaker. Below: Half-tracks and a "duck" mark a successful landing as the men move inland, supported by naval gunfire

This is by way of an account, then, of how brave men give their lives to establish and keep open the lines of communication so vital to the success of every operation, and of how equipment furnished by the Signal Corps to all branches of the Army makes it possible to weld together all units into a powerful and integrated military force. Like a well-run football team, our Army has its offensive and defensive signals. It receives them by wire and radio as the battle progresses.

In Italy, our Signal Corps units swarmed ashore with the first waves at Salerno. Some 200 tons of communication equipment were brought ashore during the first few days; and 700 miles of telephone wire—400 miles of fixed wire and 300 of assault wire—were installed within the first 10 days of the invasion. In the first 18 hours, they set up four switchboards close to the beaches, as well as six telegraph sets, and had a communications system operating over a wide area. Linemen, repairmen, and operators came ashore in the thick of the battle, carrying their own equipment.

Early in the fight, two jeeps carrying signal equipment were put out of action, thus cutting down the mobility of the signalmen, but these telephone crews loaded onto their backs all the equipment they could carry and went ahead, sometimes on their bellies, stringing wire and getting switchboards and other apparatus into operation.

They had hoped to salvage some of the wire left behind by the Germans, but they were disappointed, for the enemy had not only cut the wire

The Signal Corps' Appreciation

The Signal Corps, U. S. Army, has awarded to the American Telephone and Telegraph Company a "Certificate of Appreciation" (see page 68). Presenting the Certificate to President Walter S. Gifford during ceremonies held on June 23, Major General Harry C. Ingles, Chief Signal Officer, said in part:

"It is especially appropriate that this well deserved recognition of American Telephone and Telegraph Company's tremendous contribution to the war effort should come at this time—when Allied accomplishments on the beachheads of France are fresh in everyone's mind. . . .

"Time has always been a precious commodity in war-time, and A. T. & T.'s willing coöperation has been a valuable factor in beating the enemy to the punch. It has been possible on numerous occasions to accomplish in hours tasks that ordinarily would have required weeks.

"This work—often above and beyond the normal requirements of duty—is not reflected in any one section of A. T. & T., but it exists through all echelons, from the operators on the switchboard and the technicians in its laboratory to the highest executives.

"The eagerness and enthusiasm demonstrated by all individuals of A. T. & T. have been a source of constant pleasure and satisfaction to the Signal Corps. We are sure it will continue to be so—for the job is not yet finished."

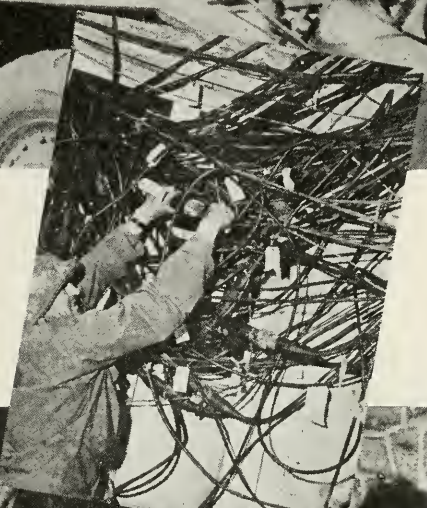
FRANCE

ONCE the beach heads are secured, there comes the stupendous task of bringing in the reënforcements—a constant and increasing stream of men and supplies

AIR SUPPORT is vital to a successful invasion. Note the throat transmitter and ear phones of this calm young co-pilot of the Eighth Air Force

CAMOUFLAGE and portable equipment indicate that this Army invasion message center is not far from the scene of battle, yet voice communication has already been established

MEMBERS of an American reconnaissance unit report by radio telephone, from a battered street in Montebourg, the passage of Allied aircraft overhead



THE "Spiral-4" and other field telephone cable shown in this picture is installed in the first Army headquarters on the Normandy beach head

IN CHERBOURG, soon after its capture from the Germans, natives and American troops listen with deep absorption to announcements about the progress of the Allies in battle only a few miles away

HIDDEN AWAY under ground, this is the "main frame room" of the telephone switchboard installation at Allied headquarters

ITALY

TWO MEMBERS of the American Fifth Army create a concealing fog while the man in the fox hole telephones reports as it spreads over the valley of the Garigliano River

but had carried away whole sections of it so as to make any salvaging operation extremely difficult. To make things even tougher, Jerry had cut down some of the poles and burned others to prevent their use by the Fifth Army. Some poles were left, but these were rigged with booby traps.

FORMIDABLE natural barriers and an enemy sharply aware of the importance of communication lines added further to the difficulties on the Fifth Army front. Italian rivers, swollen by heavy rains and well covered by enemy machine gun and small arms fire, claimed the lives of many signalmen, our official reports show.

"Despite biting cold and strenuous hostile opposition, linemen have waded and swum the rivers in order to establish lines of communications," said one report. "The procedure is to tie a section of the wire or cable around a man's waist, bid him 'good luck' and try to cover his crossing with supporting fire. Once over, it becomes necessary for the swimmer to dig in and take whatever the enemy offers in opposition, then set up for business when the fire lessens, so that communications with the forward division can be established as speedily as possible."

Not only must Signal Corps units establish the communication lines, but they often must defend them. On that same Salerno beachhead, 16 powerful radio sets had been installed when a German attack was launched. The attack was successful in that it forced a temporary withdrawal of all Allied units—except the radio team of a signal battalion, which got orders to hold at any cost.

"For 20 hours," the official report said, "this detachment remained the most advanced unit of the Fifth Army, almost four miles ahead of any possible support. At no time during the enemy thrust had communications been lost, although a German patrol attempted to destroy a transmitter installation. Radio operators, maintenance men, and officers grabbed sub-machine guns, rifles, and carbines, and repulsed the patrol with losses."

The unit finally withdrew, but only after receiving orders to do so. At a critical stage of events, it had prevented a confused military situation from becoming a chaotic one.

During the first 22 days of the invasion of Italy, more than 5,300 miles of assault wire, field wire, and cable were laid by our Signal Corps units—an average of better than 240 miles a day. This was accomplished in spite of adverse weather and difficult terrain. Whereas, in earlier campaigns, linemen worked from standard military vehicles adapted specifically to their work, they were forced here to resort to mules, carts, jeeps, and even bicycles. It was not unusual to see linemen unrolling huge spools of wire or cable by hand, while other men of their units were on constant patrol duty against enemy forays.

A Liaison Service

SIGNAL CORPS communications are not limited to land operations. Contact with ships in the harbor was established at almost the precise moment the first troops set foot ashore in Italy. And, in order to furnish the high command with the necessary verbal picture, the signalmen frequently got out ahead of the combat

PICTURED during the campaign in Sicily, this is the switchboard room at the Signal Section of the American Fifth Army

PORTABLE carrier equipment and telephone and teletypewriter in the Signal Center photograph

ITALY

TESTING CIRCUITS and looking for a wire break, these two men were snapped near the front during action in Sicily

MEMBERS of an anti-aircraft battery are dug in by the tracker unit of an M-9 electrical gun director. The man at the right is in touch with a portable information center which plots electrically the flight of approaching enemy planes

THE CREW MEMBER with the telephone receives from the computer unit of the M-9 Director, and gives to the team, the word to fire. Fuses are set and gun is aimed automatically

In constant touch with their own forces by telephone, these U. S. soldiers are on reconnaissance for an artillery battalion in Tunisia

NORTH AFRICA

Here a couple of American soldiers are laying field wire in rugged terrain

Somewhere near Algiers, French soldiers learn from American soldiers how to operate a field telephone switchboard. To the right is an Army scout car with radio telephone equipment

troops. One signal company in Italy actually went ahead of the Infantry, with the result that the information they phoned back to the heavy guns of the destroyers, cruisers, and other craft brought about the destruction of German Mark IV tanks which had threatened the whole landing party.

One observer attached to the Fifth Army reported that, although virtually every type of signal equipment was in use during the landing operations in Italy, the handie-talkie won its full share of acclaim from the men. This small portable radio set, which permits the platoon to communicate with its company commander or battalion leader instantly, provided much-needed contact with isolated groups and parties sent forward to reconnoiter.

THE BATTLE for the Salerno beachhead offered a first-rate example of how modern communications are used to coördinate the work of the ground force and its supporting air arm. When the battle began, coöperation between the ground troops and the Army Air Forces was so precise that dive-bombing requests from the Infantry were actually passed on to the attacking planes while they were in the air on their way to, or immediately over, the invasion area.

Fighter-bombers and dive-bombers hit enemy positions within 10 to 30 minutes after the ground troops had relayed the location of the targets. By the use of radio telephone equipment furnished by the Signal Corps, direct contact was maintained between the Infantry and the AAF's ground control station on the beachhead. When advanced ground forces needed supporting aircraft to hit strong enemy emplacements, messages were relayed to the control station and immediately radioed to the air elements. The control station operator described the exact nature of the target, its location and importance, and actually briefed the pilots while they were in the air heading toward the battle ground, we learn from AAF sources.

AAF personnel at Salerno reported that one of the principal reasons they were able to afford a protective aerial screen for the landing operations was the fighter control system. One fighter pilot put it this way:

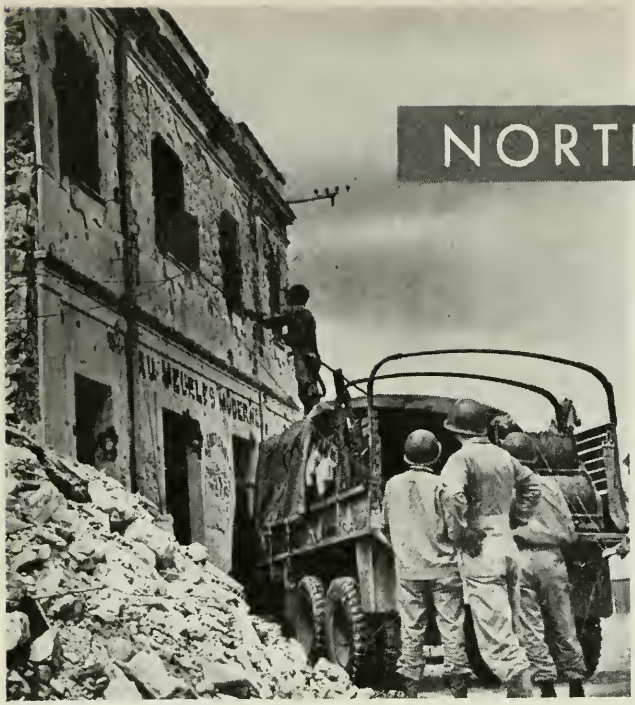
"That control system was marvelous. I remember once when they called me and said, 'Fighters approaching you, now a mile away,' and gave me the direction. Then they called back and reported, 'Fighters now half a mile away.' A moment later they called and said, 'Heads up, here they are.' I looked in the designated position and, sure enough, there were the Germans."

Wire and Radio

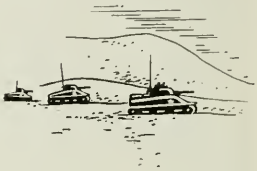
WIRE and radio communications supplement each other in this war. A battalion wire chief with an infantry division, recently returned to the United States on rotation furlough, said the German artillery fire was so fierce and continuous at the Anzio beachhead that American linemen had to work 24-hour shifts to keep communications open. His outfit, he reported, laid more wire at Anzio than anywhere in Africa or Sicily.

"Twice our Command Post was blasted over our heads," he related, "and although we finally resorted to using double lines and radio, we had

NORTH AFRICA



U. S. Signal Corps linemen string telephone wires through Mateur a few hours after forward troops had taken the town



On tall French poles that line the road to Gabes, Signal Corps men run American telephone wires while battle rages in the distance

Early in the African occupation this Army operator dug his switchboard in behind the beach to serve a battalion headquarters

a hard time keeping communications open."

This man, incidentally, received the Purple Heart for wounds sustained near San Stefano in Sicily last year. Of this he said:

"We were putting in wire at 'Million-Dollar Hill' and a shrapnel burst got me. We called it 'Million-Dollar Hill' because we figured we threw a million dollars' worth of artillery shells at it. Then the Infantry had to go in and dig the enemy out."

The Sicilian Campaign

ALTHOUGH radio was widely used during military operations in Sicily, wire remained a vital medium of combat communications. Reports from commanders of Signal Corps field units emphasized the ability of wire-laying crews to maintain communications at a pace which matched that of the advancing Infantry. The security and accuracy with which a large volume of traffic was carried by telephone lines were also cited.

During the battle for San Fratello, it was necessary to lay a five-mile line of wire over a rocky, trackless mountainside where a man could move only by the frequent use of his hands, and another line for 15 miles where the wire could only be carried by pack animals and laid by hand. One six-mile line from the coast road to San Marco required 24 hours to put in operation because the winding, narrow mountain road on which it was laid was under constant shell-fire.

In the landing operations in Sicily, the wire was brought ashore and laid from quarter-ton trucks. Additional wire was landed and transported inland in two-wheeled, quarter-ton trailers, six miles of wire being carried with each of the signal teams landed. Wire communication with all regiments was put in operation as soon as physical contact with the regiments was established.

An Infantry commander added this commendation to the work of the communications troops in Sicily:

"During the operation, wire communication was desirable down to rifle companies and battalion observation posts. The terrain was very mountainous and the highways impassable to vehicles, due to blown bridges and anti-tank mines. Thus it was necessary for the battalion communications platoons to carry their wire and equipment by hand. . . . Lines frequently were broken by artillery and mortar fire, by animals and vehicles, and sometimes by enemy patrols."

IT WAS estimated that communication units in Sicily rehabilitated 950 pole line miles, 49,176 wire miles, and 24,588 circuit miles of communications. In addition, they laid more than 1,800 miles of Spiral-4 cable, over which seven telephone and telegraph messages can be transmitted simultaneously and secretly when utilized with "carrier" equipment.

Spiral-4 cable was used with great success in North Africa, Sicily, and Italy. It combines the advantages of multi-channel telephony with the speed with which the cable can be laid. Its quarter-mile lengths are snapped together with waterproof connectors as rapidly as the flexible cable is unreeled. While the cable is usually laid along the ground, it can be buried when time and condi-

COMMUNICATION with island or carrier base and within the plane is important in connection with landings on the islands of the Pacific

PACIFIC

MARINES set up this switchboard on a beach on a Southwest Pacific island

LANDING CRAFT bring vast quantities of supplies ashore —on one of the Marshalls group in this picture. Note the men at the lower right who are establishing communications

tions permit, thus protecting it from damage by vehicles or marching troops, or by the enemy.

In Sicily, American wire teams found several German lines equivalent to our Spiral-4, but it was far quicker for them to lay new Spiral-4 than to attempt to service or rehabilitate the German cable, in view of difficulties in locating the faults.

In North Africa

MUCH of our success in the North African campaign was attributed to the accuracy of our concentrated artillery fire.

As one artillery officer put it: "We gave them a hell of a beating. We have such good communications that we can lay down concentrations of our guns at any point at any time, and there isn't much that can come through alive."

Sometimes the old Yank ingenuity was put to severe test to provide the communications necessary for artillery fire control. I like this story of a triple play pulled on the Germans in the drive toward Bizerte:

Our forces had driven north of Lake Achkel, west of Bizerte, and were being held up by German batteries. Our guns were in a position to fire from that position, but the cannoneers couldn't find a high point from which they could get a forward observation. Another American combat team, which was without artillery support, had taken a crest south of the lake. These men could see the enemy gun positions and were preparing to act as observers for our batteries north of the lake when direct comunications failed.

But the Yanks were not to be balked. From the crest south of the lake an observer routed a call over Army signal lines to a switchboard 100 miles to the rear, thence forward over another circuit to our guns north of the lake. In a few minutes he had adjusted the fire of the Yank batteries and their shells began dropping on enemy gun positions, with the result that the Germans withdrew hastily and the American advance continued.

WHILE WIRE has been a basic medium of communication in the European, African, Mediterranean, and Caribbean theaters of operations, radio is not only the primary means but in many cases the only method of communication in the Pacific, because of the huge expanse of water over which our war with Japan is being waged. Out there our offensive has been a series of landing operations, and in these landings radio carries the main burden, particularly until our men have been put ashore. Wire is used laterally after landings are accomplished, and inland after the beachhead is established. Telephones are used to especially good advantage in connecting the beach with inland fire control parties.

Where possible, every effort is made to maintain wire circuits for ground troops. For security reasons, radio silence is observed when wire lines are operating. Radio circuits are usually necessary for contact with reconnaissance elements which are landed on other islands or at distant points on the same island. Such was the case at Guadalcanal.

In the Pacific

I RETURNED not long ago from an inspection tour of Signal Corps installations in the Central, South, and

THESE Signal Corps men are getting ready to run field telephone wire along the edge of a swamp in New Guinea with the help of husky natives and an outrigger canoe

TELEPHONE field wire is being paid out under heavy guard from a "duck" on one of the Admiralty islands

THESE American soldiers (below) are advancing under Japanese fire. The second man is reporting by telephone

Southwest Pacific theaters. The jungles in the Solomons and New Guinea are the worst I have ever seen—much more difficult than those of Central and South America. They have such a blanketing effect on radio that the walkie-talkies don't transmit with their normal range, particularly if the jungle is wet. This is one of the reasons why the Signal Corps lays telephone wire networks on shore as soon as possible in these islands.

Our communication problems in the Pacific theaters are somewhat different from those in Europe, but they are equally hazardous. Here, as in all other theaters, Signal Corps men are found among the advance detachments. Along with the Infantry, they splash ashore from the snub-nosed landing craft in the face of bitter enemy resistance, to wrest from the Japanese another stepping stone on the road to Tokio. And while the Infantry crashes through the tropical brush picking off the stubborn Japanese, our signal troops don leg irons and climb trees through which bullets are whizzing, to string the telephone wires which will connect the task force and its individual units with the Division Command Post.

Occasionally one of these linemen a-top a tree-pole will hook his pliers to his belt and pull out an automatic pistol to send a Japanese sniper hurtling from his tree-top perch. Then, re-holstering his automatic, the Yank lineman will take up his pliers and go on with his job of wire splicing.

Jungle Right-of-Way

SOMETIMES a signal company is called upon to clear its own right-of-way and build a telephone pole line through uncharted jungles and across mountains. Such was the mission of Company C, an untried outfit which disembarked from LST boats at Lae just after it was retaken from the Japanese.

Company C's job was to construct the line in a river valley through miles of New Guinea jungle and mountains, Kuna grass and marshes, forest rivers and insects. Engineer units had cut through here and there along the route to build air strips, and it was to supply these bases with communications as well as eventually to establish longer lines to bases not then captured, that the project was undertaken.

True, units of an aviation signal construction battalion had previously pioneered a route to the air strips, but the pole line was to follow this route only in part. The aviation signalmen had strung Spiral-4 cable along the ground, and this cable was in operation when Company C came along. But building a pole line was something else. It required from eight to 20 tons of material to the mile, and its builders needed a ton of food and other expendables per day. Every ounce of it had to be brought from Lae over an ever-lengthening line.

For the first leg of the line there were no poles, so the outfit cut its own poles while clearing the right-of-way. It took from October 11 to January 17 to push the pole line 25 miles, and the worst trials were still ahead. They got help from the Australians in the form of 120 officers and men; supplies came by truck from the Headquarters company; and the Air Force furnished "biscuit bomber"

PACIFIC

THE "lineman's helper" at the right on this palm tree which is about to become a telephone pole needs no climbers

THIS mortar battery is "on call" at any time to lob a few at the Japs on the Arawe peninsula

A Marine Corps communication unit stands by at radio telephones on the beach at Roi Island of the Kwajalein atoll

This picture gives some idea of what it is like to build a telephone pole line through the New Guinea jungle

Two strands of "Spiral-4" telephone cable are about to go amphibious and become submarine cable for a short distance

ALEUTIANS

COMMUNICATIONS played an important part in the occupation of Attu. Here a beach master is giving directions through microphone and loud speaker to landing vessels which are bringing more supplies ashore

THE AMERICANS found this Japanese telephone shack intact after the enemy had fled Kiska, and took it over and put it to use at once

ABOARD SHIP, these men of the Army Signal Corps keep in touch with a landing party by means of this radio telephone equipment

planes that regularly dropped rations and supplies to the advance party laying out the route miles ahead of the construction teams.

Yes, they finished the job. Their worst enemies wore no uniforms. Instead, their fight was against raging rivers, clinging grass, enveloping mud, stubborn jungle, towering mountains, tiny insects, and tinier germs.

Japs on the Line

THE JAPANESE place strong emphasis on disrupting our lines. Our soldiers often can traverse wide areas, known to be infested with enemy snipers, without drawing a single shot; but let a single soldier of ours stop and appear to be repairing a break in a telephone line, and immediately snipers' bullets will begin to whine all around him.

On one Pacific island Jap bayonets severed our wires in some areas at an average interval of 20 feet. This disrupted communications rearward for some time. In other cases, the enemy used bayonets to scrape insulation off our wires, grounding circuits. The Intelligence Center reported an incident in which a Japanese was killed while tampering with one of our wires. An American lineman found his stiffened body, with both hands clutching the wire; the wire also was clamped between the dead man's tightly gritted teeth. He had stripped the insulation cleanly for at least six inches, to short the circuit.

THE SOUND-POWERED telephone, used extensively in the Navy, has also proven valuable to ground troops in the Pacific. Its worth was demonstrated as long ago as the capture of Guadalcanal, where it was used for fire control of infantry mortars and of units within an infantry company. Since at night all men were told to stay in their foxholes and warned that anyone moving about would be fired upon, these telephones gave the company commander control of his small units without the necessity of moving about.

Because of the short land distances involved in the Pacific island operations, the sound-powered telephone also has been used effectively for artillery fire control. Absence of batteries, which are susceptible to deterioration from the humidity and dampness of the islands, makes this instrument smaller, lighter, and more durable than battery-powered telephones.

THE REPORT brought back to the United States recently by Colonel Philip G. Cochran, commander of the First Air Commando Force in Burma, told how greatly an excellent radio communication system contributed to the successful operations of the Anglo-American forces behind Japanese lines. The British Chindit Forces, commanded by the late Major General Orde C. Wingate, were on the ground and Colonel Cochran's Air Commandos were supporting them.

"The British found targets and then got us on the radio," Colonel Cochran related. "We went to greater detail on ground support than I have ever heard of.

"We had a system where I could call any of our fields in Burma. I'd say, 'Get me Clint on Broadway,' (the name the Commandos gave one

MAJOR GENERAL CLAIRE L. CHENNAULT, commander of the U. S. Fourteenth Air Force in China, directs operations from his command post during a Jap air raid. Note the field telephone switchboard

U. S. ARMY ENGINEERS build a communication line along the new Ledo Road in North Burma

BURMA

CONTACT with observers is maintained by radio telephone as these American troops in Burma wait for the signal to attack a Jap machine gun nest

of their fields). I would get him and say, 'What do you need?' He might say, '500 gallons of gas and food.' I'd say, 'O.K.,' and the cargo planes would take it to him."

The Signal Corps and the Telephone Companies

In all, the Signal Corps is supplying more than 90,000 different items to our fighting men. Even the most sensitive electrical equipment is standing up remarkably well, considering the terrific beating it takes when it is unloaded in landing nets and dumped on beaches in all kinds of weather. Water- and fungus-proofing are undoubtedly adding to the life of the equipment.

This fine equipment would mean nothing without the skill and bravery of the men out there in the front lines. I have unbounded admiration for those who have given their lives, and for the other thousands who have risked theirs, in order that the all-important communication lines be kept open. War Department records tell the story of many thousands of signal men who have exposed themselves to enemy bullets, and even to battle cross-fire, while laying sorely needed communication lines or repairing lines damaged in battle. Many of them have been decorated by their Government for extraordinary heroism and devotion to duty.

It has been said before now that all telephone people are, indirectly at least, members of the Signal Corps. That is well deserved recognition of the importance of communications, and of those who provide it, on the home front. On all the fighting fronts, as you who read this undoubtedly know, are thousands of men who

Communications and Air Power

How important is a communications man? Three or four years ago, when you or I sent a telegram across the continent or made a long distance call, we never considered the number of people involved, nor did we consider the speed and efficient service any great feat. However, today, many of us have begun to realize that communications are a big factor in winning a war. Yet, very few of us now are aware of just how important the passing of information from one point to another really can be. It is essential to all arms of the service; and, if possible, more important to the Air Forces than to any of the others.

With airplanes flying faster and covering greater distances as each year passes, we find that communications have become speedier, more efficient, and much more essential. This increase in importance of communications has automatically increased the importance of the personnel involved. Every landing, every flight, every bombing mission, and every fighter engagement cannot be accomplished without involving scores of specialists in the communications world. In the Philippines and in Australia, I have seen many times a mission whose success depended greatly upon the efficiency of communications. Because it is a job for skilled specialists, because it is a twenty-four hour duty, and because it means many times the success or failure of the mission, communications are and will be one of the most vital duties during this war.

General H. H. Arnold
Commanding General, AAF

joined the Signal Corps directly from the ranks of telephone companies all over the United States. So did many others who have been assigned to comunications jobs in other units. Their peace-time training and experience have proved invaluable to the Army. To them, and to the organizations from which they came, I take the opportunity afforded to me in this telephone publication to give cordial and grateful recognition.

In the midst of the gunfire and sacrifice is a love of familiar things back home. In New Guinea, I visited one of the signal headquarters, which consisted of a one-story shack made of salvaged lumber and grass. There was a sign about as tall as the shack itself, and on it was painted in large letters: "The Pentagon."

It made me feel very much at home.

Home is exactly where every last one of our fighting men wants to be just as soon as the enemy is thoroughly beaten. To speed the day of his return, we of the Signal Corps, with the help of the great communications industry, will see to it that he is given every military advantage that expert communications can provide.

We are, of course, thinking about post-war problems, but we realize that our most important contribution to post-war is to hasten the day of victory; for nothing can contribute more to our country's prosperity and well-being than the earliest possible victorious ending of the war—both in Europe and in the Pacific. The longer the war lasts, the greater the loss of life; the greater the number of wounded who will be permanently disabled; the greater the national debt; the greater the risk of dangerous inflation; and the greater the danger of peacetime continuation of wartime governmental controls—for the longer these have to be in effect because of the war, the more they tend to become permanent. So, our post-war plans begin with doing everything we can to help win the war as quickly as possible.

There is every indication that we, in the Bell System, will have plenty to do when the war is over. We have the very agreeable prospect of welcoming back our employees who are in the armed services—there are now more than 55,000 of them. Some, I regret to say, can never come back; already there are three hundred and eight gold stars on our flag. Some—very few I hope—will have been disabled and will need special attention to fit them into jobs they can fill. Others may need training in new skills, but all will get a personal and a warm welcome.

From President Walter S. Gifford's statement to A. T. & T. stockholders at the Annual Meeting on April 19.

The System's Safety Program Is Based on the Principle That Fewer Unsafe Practices Mean Fewer Accidents and Fewer Accidents Mean Fewer Injuries

The Bell System's Safety Observation Plan

Erle S. Miner

PROMOTION OF SAFETY is a never-ceasing activity in the Bell System. Not that telephone work is unduly hazardous; but each personal injury, serious or minor, which does occur as the result of an accident is potentially a human tragedy—and ought not to have occurred. Much more than just a catch phrase is the challenging slogan: NO JOB IS SO IMPORTANT AND NO SERVICE IS SO URGENT THAT WE CANNOT TAKE TIME TO PERFORM OUR WORK SAFELY.

Experience has proved that sporadic "safety campaigns" are only temporarily effective; and as the need for education and for the adoption of safe working habits has become better understood, there has been a paralleling development in the methods by which these may be accomplished.

One method recently introduced in the System, and already promising to be of great value, is the Safety Observation Plan. Its principal feature is that, in carrying on their day-to-day jobs, Plant Department supervisors at the various organization levels, and particularly the first-line supervisors who are directly responsible for the safety of their men, make "observations" of work while it is in progress. Observations cover the use of tools, material, and equipment, as well as any unsafe method or order of procedure in performing the work which indicates a lack of planning or failure to take into account all the circumstances surrounding the particular job.

The plan incorporates procedures developed and used by a number of System companies over a period of years. These procedures have varied somewhat as to the making of the observations, the time allotted, the collecting and summarizing of the data,

and the way in which the data were used. In general, however, provision was made for a series of observations of men while at work so that steps could be taken to reduce unsafe practices. If the number of unsafe practices due to the lack of training and wrong work habits can be reduced, then the probability of accidents and personal injuries resulting from such unsafe methods will also be reduced.

Analyses indicate that some 60 per cent of accidents are caused by the use of non-standard or short-cut methods rather than the safe and proper ways—learned by experience—which are outlined in the Bell System practices, safety codes, and other local instructions. Another 10 per cent of accidents are attributable to faulty supervision and poor planning. Consequently, any procedure that will aid in detecting unsafe practices, their frequency and their causes, can be followed by properly focused training and supervisory efforts leading to a safer and more efficient job.

The plan is similar in some respects to the established preventive-maintenance programs and quality-inspection plans. In these activities, plant conditions are observed, results are studied, and corrective measures are taken prior to the interruption of telephone service. In the safety observation plan, unsafe practices observed at the time the work is being done are normally discussed at the

INTEREST in the Safety Observation Plan begins at the top. Here a general plant manager signifies his approval of its adoption at a meeting of his division plant superintendents

ALL LEVELS of plant supervision get behind the Plan. In this picture a district plant head explains it to a group of first-line supervisors

time with the employee or employees, and corrective measures are taken before accidents can happen. The plan is a sampling procedure for determining the frequency as well as the causes of unsafe work practices, so that preventive efforts may be more effectively directed where required.

The "observations," each usually of 15 to 20 minutes' duration, are recorded on small "Unsafe Practice Observed" forms. Unsafe practices and their causes, as well as recommendations for general training courses, issuance of new or revised instructions, etc., which appear to be desirable, may be made in the space provided. These small forms are forwarded through lines of organization to the district plant superintendent or comparable group head, where they are summarized on larger forms. District summaries are combined to make division and area summaries. District, division and area organizations study the reports and summaries and, on the basis of such information, take action which will assure:

1. That the real underlying causes of the unsafe practices are determined.
2. That needed training projects for certain forces, groups, districts, divisions or areas are designed and carried out.
3. That improvements or changes, if advisable, are made in Bell System practices, safety codes, and other instructions.
4. That additional supervisory attention is given when and where required.

THE Safety Observation Plan provides material for meetings at which line gang or central office force discusses possible hazards associated with the work being planned

ON FIELD TRIPS, supervisors are on the lookout for signs of danger, close calls, work operations carelessly carried out. Meetings on the spot drive home the safe way of doing the job

One Operation—Three Situations

Situation I (left): If, when he is through with the hand axe, the lineman on the pole replaces it securely in the keeper of his body belt, no accident occurs

Situation II (right): In this picture, the man on the pole did not make certain that the axe was securely in its place. It fell, missed by a few inches the man at the foot of the pole, and lies on the sidewalk. An accident occurred—but no injury

Situation III (right): A few inches make a great difference; for the axe this time did strike the head of the man below, causing serious injury—which receives immediate first aid

These three pictures were posed to illustrate that following safe working practices—as shown in *Situation I*, for example—is the key to safe and efficient operation

5. That any other necessary changes are made in the existing safety programs.

In an endeavor to bring about improvements in the plan and to stimulate its functioning, it has been found advisable to discuss the results of the observations at supervisory and employee meetings held at regular intervals throughout the year. Emphasis is placed at these meetings on the safe and efficient way of performing the various work operations, and motion pictures, posters, safety publications, and other aids are used to focus further attention on those practices most likely to result in accidents and personal injuries.

Safe Working Habits Are the First Step

FUNDAMENTAL to the application of the safety observation plan is this principle: *fewer unsafe practices mean fewer accidents, and fewer accidents mean fewer injuries.*

To make clear this point, consider for a moment three situations which are inherent in an operation common and familiar in outside plant work: a pole replacement job.

In Situation I, a line crew is at work, with one lineman up the pole, using a hand axe to make good the attachments transferred from the old pole to the new one. Another lineman is completing the back-fill at the base of the pole. A third lineman has just pulled the "nose bag" up to the first with some additional equipment. The foreman stands nearby, watching the entire operation. Before reaching out for the bag of equipment, the lineman on the pole places the hand axe in the keeper of his body belt—and that is that. There is no accident and therefore no injury.

Situation II is identical except for this one point: the man a-top the pole let go of the hand axe without making sure that it was in the keeper of the body belt. The foreman shouted a warning—but too late. The tool slipped, whizzed past the ear of the lineman at the foot of the pole, bounced on the concrete sidewalk, and came to rest near-by. In Situation II the accident did happen—but the men laughed it off. After all, nobody was hurt.

Situation III also differed only in this one respect: that the hand axe took a different course by a mere six inches—and struck the lineman below on the head. The victim is given skillful first aid and a quick trip to the hospital. He suffers pain, the possibility that the consequence may prove to be serious. Production of that gang is interrupted. That accident resulted in injury.

Now these three situations can be fitted into the basic principle. In Situation III, a man was injured. Situation II is just one of the many cases where something went wrong —but differs from Situation III only because no one was injured. The same series of events took place, but the lineman at the foot of the pole happened to be just outside of the line of the falling hand axe and was uninjured.

BUT WHERE does Situation I fit into the picture? It is the key to the problem, because the events or unsafe practices in Situation I, or a number of similar situations, led up to the accident which caused the injury. It is much too late to apply corrective

action in Situation II, because the unexpected event has happened and it is only by chance that an injury of some kind does not take place.

Who would venture a guess as to how many unsafe acts take place before an accident occurs? How many times before has one man worked on the ground directly below another on the pole, and how many times has the man on the pole placed a tool in the keeper of his body belt without making sure it was fast before he let go? How many times has the foreman permitted one man to work on the ground beneath another man in the air? How many times has the foreman watched his man put tools back in his belt to see if he always makes sure the tool is in the keeper before he lets go? The answer is—many times. Whether the number of "Situations I" or unsafe practices take place a hundred or a thousand times before an accident occurs is not known. But it is evident that in order to reduce the number of injuries to employees, the number of incidents or errors that lead up to the accident must be reduced. That is,

Bell System safety practices provide that the employee first make the ladder secure and then make himself secure to the ladder. It helps to prevent falls

A pole must be tested before it may be climbed. This employee has already determined its condition at the ground line and is here making the pike-pole test

Situation I must not take place if Situations II and III are to be prevented.

The System Safety Record

THAT telephone work is relatively safe is evidenced by recent safety records established by some of the units of the Bell System. One plant division of about 650 men has worked seven years without a single lost-time accident, and an area having 1,500 men has worked more than two years without a lost-time accident. These are but a few of many cases that could be cited, and they all exemplify what can be done.

The telephone companies are not satisfied with outstanding records, however, as long as any accident occurs that could have been prevented. That there is still a job to do is indicated by the following summary of unsafe practices observed during the first year the safety observation plan was in operation in one large organ-

WHILE inspecting cable, this repairman wears two highly important pieces of safety equipment: body belt and safety strap. It is the coöperation of employees in observing such safety practices which makes possible outstanding safety records in the Bell System

ization. It should be remembered that these figures represent the results of many thousands of observations of the work of some two thousand men during the entire year.

Motor Vehicles	342
Tools and Materials	1059
Rubber Equipment	28
Miscellaneous	152
Total	3447

AT THE START of each job, the foreman and his men study what is to be done and plan how to do it. Analysis of potential hazards helps men to work in safety

	Number of Unsafe Practices Observed
Ladders	562
Hand Line	165
Safety Straps and Body Belts	199
Climbers	188
Goggles	97
Poles Aloft	130
Poles, Other	118
Working Aloft, Other	52
Guarding Employees and Public	355

As a matter of further interest, the 562 ladder unsafe practices include 34 cases of over-reaching, 63 cases of not tying pull rope to rung, 33 cases of working on an unguarded ladder at a hazardous location, and others. Space does not permit a detailed list of all the specific unsafe practices included in each classification, but their types can be assumed from the examples given.

While the number of unsafe practices listed above might make it appear that safe practices in this particular organization were extensively disregarded, quite the opposite is true: the total of observations made indicates the extent and thoroughness of the coöperative efforts being made to eliminate accidents.

Fortunately, most of the unsafe practices, whether committed on the job or off, do not result in accidents and personal injuries. Continued improvement lies, of course, in eliminating, in so far as humanly possible, all unsafe and inefficient operations. This is what the safety observation plan is designed to accomplish.

While the plan is similar to other plans developed and used in the plant and other departments, for sampling results and focusing attention on where to obtain improvement, it differs in one important respect: most of the other sampling procedures provide for inspecting the completed work, while the safety observation plan provides for observing the work in progress. For this reason, the plan should be particularly helpful in establishing the habit of observing the circumstances surrounding the job

LIKE ALL plant supervisors, the foreman has a definite part in the Safety Observation Plan. This one is watching a lineman putting a cross arm in place

before the work starts, and looking one step ahead as the work proceeds.

This same habit of always looking one step ahead should be helpful in reducing off-the-job accidents as well as those which happen on the job. This is because a person who has developed this habit on the job will be more likely to look one step ahead and less likely to take short cuts or chances wherever he may be. When a person has developed the habit of always observing circumstances and acting on them to the same degree with which he observes them when driving an automobile or crossing a street, he will not have an accident.

THE Safety Observation Plan, which was made available last year to all Bell System operating companies for study and consideration, has not been in operation a sufficient length of time to determine fully its effectiveness on a System-wide basis. Several companies have reported that it played an important part in reducing accidents during 1943. In one company, for example, where the plan was introduced during the first part of that year, very rapid progress has since been made, lost-time accidents being reduced to less than three-fifths of the number experienced during the previous year. It was the opinion in this company, as well as in other companies having similar experiences, that the stimulation of interest in safety brought about by the preliminary meetings, and by the operation of the plan itself, was the principal contributing factor in reducing accidents in their territories.

Experience with the plan indicates that it can be introduced and administered so as to enlist unstinted coöperation from all ranks of employees, to the end that each day's work may be completed without injury to anyone. As on a football team or in a Flying Fortress, so in performing telephone work, coöperative effort is important to safe and efficient accomplishment.

The safety observation plan is not primarily a war measure to "conserve manpower for warpower." It is to help assure a continuing and effective safety program during the remainder of the war, during the postwar period, and for years to come. It is only through the administration of organized activities such as the safety observation plan, designed to make full use of the combined experiences and coöperative efforts of thousands of telephone men, that favorable results continuing year after year can be achieved.

THERE ARE 12 cities in the United States with a population of 50,000 or more which are served by independent telephone companies. Lines of all of them are connected with the Bell System. The cities are: Durham, N. C.; Erie, Pa.; Fort Wayne, Ind.; Johnstown, Pa.; Lincoln, Neb.; Long Beach, Calif.; Rochester, N. Y.; St. Petersburg, Fla.; San Bernardino, Calif.; Santa Monica, Calif.; Terre Haute, Ind.; and York, Pa.

Maintaining Interest in Customers When We Have Nothing to Sell, and So Handling Contacts as to Gain Their Understanding, Are Today's Business Office Objectives

We Don't Like to Say "No"

John W. Ord

"IF ANY of you listening in are among those who would like to have telephone service in your homes but haven't been able to get it, we want to say that we here in the Bell System don't like to use the words 'No' and 'We don't know when' any more than you like to hear them.

"We have a pretty good idea how you feel when you want telephone service and can't get it. We know how 'We're sorry' sounds to you when, as an applicant for new service, you move into a new place and find that the previous tenant's telephone must be put back into the common 'pool' to fill an order ahead of yours —or when you ask just how long you'll have to wait and we are unable to tell you.

". . . your patience, coöperation and understanding are genuinely appreciated by all of us."

That statement, voiced in behalf of the Bell System during "The Telephone Hour" radio program on June 19, 1944, bespeaks particularly the feelings of some ten thousand women service representatives handling contacts with the public in the business offices of the System companies and men who act as outside representatives. That these representatives should show such an interest in customers is no accident: it is due to a determination to maintain the best possible service in handling contacts with customers, despite the difficulties which the telephone companies face under war-time operation. Some measure of these difficulties is furnished by the fact that the Bell companies are holding on their waiting lists more than 1,250,000 unfilled requests for main telephone service.

The maintenance of good business office service in the face of these and other war-time difficulties has been given special emphasis because of the unique and important place of the telephone business office in the relationship between customer and company.

The business offices handle about 40,000,000 incoming contacts a year, exclusive of payments, and these cover a wide range of subjects. When customers deal with a service repre-

Business office representatives . . .

sentative in the business office, they usually feel that they are talking to some one representing the management of the company and reflecting its official attitude. The impression upon customers is, therefore, most important; and the Spirit of Service has been established as being fully as essential in the conduct of business offices as in other phases of telephone operations.

The business office must of course be efficient in such matters as prompt attention to customers, and accuracy, for instance. But something more than efficiency is necessary for service to be fully satisfactory, and what are known as "overtones" in service have been stressed with the idea of making the business office a place with which customers like to do business: friendly, understanding, and giving its customers individual—as opposed to routine—treatment.

It was early in 1941 that the telephone companies first began to consider the possible effect upon business office service of having nothing to sell. It came up in connection with a program of conservation of telephone facilities and materials which the Bell System undertook voluntarily when the possibility of war focussed attention upon national defense. This program called for a change from the Bell System's traditional sales policy of promoting the use of the many items of telephone service through

. . . are key figures . . .

discussion with customers of their use and value.

The business offices had participated actively in sales work. In 1940, for instance, more than 800,000 additional items of service were installed as a result of their efforts. If business office people were simply asked to stop selling, the quality of business office service might be affected—because experience had shown that selling stimulated increased interest in customers and service, for the very simple reason that in order to sell, one must please. This point of view not only affected the handling of applications for service but also had a beneficial influence upon other types of customer contacts.

The illustrations on this and the opposite page are from a specially developed slide film, "Selling Shortages," which was used throughout the System to help establish point of view in handling applications and to encourage study of the best contact technique.

A great deal of thought was therefore given to planning and introducing the change from selling so as not only to achieve the best results from the standpoint of conservation but also to avoid any lessening of representatives' interest in customers. It was decided to treat it not as a retreat from sales but as a temporary change in sales direction to meet new conditions—never losing sight of an ultimate return to normal selling.

Promotion of the best use of the telephone services would continue, therefore; but it would not be directed, as hitherto, toward providing the greatest aid or convenience in business or the home, but toward

. . . in gaining customers' . . .

helping customers to get along with minimum telephone facilities and making the most efficient use of their existing equipment. The appeal to customers would be to coöperate as a voluntary contribution to conservation of materials, thereby assisting national defense. As much care was taken to establish this point of view in the business offices, and to develop appropriate techniques to help in discussion with customers, as business men would expect in a campaign to build up dollar sales.

This approach appealed to the representatives because of its timeliness and sincerity. They no longer discussed, for example, the convenience of another telephone in the home or the advantage of an individual line over party line service. If customers asked for these better services, representatives showed the same enthusiasm they did in selling, as they explained the need for conservation and determined whether the customer could "make do" with what he had. Any apparent contradiction of their past sales activity was avoided by making it clear that they would like to provide these better services and that they appreciated the sacrifices involved in doing without.

In such ways as these, interest in customers was successfully maintained. The coöperation of the public as well as the representatives was most gratifying, and there was a substantial contribution to conservation.

This proved to be only a curtain raiser before the big show; for instead of seeing if the applicant could do without, it became necessary soon

. . . understanding and confidence

after Pearl Harbor to start saying "No" to many customers applying for service or for changes in their service. The demand for telephones, business and residence, reached unprecedented levels. In view of the need for using critical materials and the telephone industry's manufacturing capacity for war purposes, the Bell System's voluntary program of conservation was superseded by Government orders placing limitations upon additions to telephone facilities and, under certain conditions, upon the installation of service for customers.

What Denials of Service Might Mean

THE CONNECTION of certain services, such as extension telephones in residences, was prohibited. Requests for other services, such as the main telephone in a residence, had to be denied in localities where a company ran out of facilities; and this condition became increasingly more widespread—until by the end of 1943 it was countrywide. As a result, requests for more than 2,500,000 of the many different items of telephone service have had to be denied since the spring of 1942.

Having actually to deny service to customers raised many serious questions.

Would refusal of service mean losing the telephone company a friend?

Might applicants think there had been some lack of foresight or shortcoming on the part of the company, particularly in case of facility shortages?

If applicants were told about the Government limitation orders—as seemed desirable—was there the danger of seeming to blame the Government, which would be neither fair (Government was only doing what was necessary to win the war) nor patriotic (any dissatisfaction might react upon civilian morale)?

As waiting lists grew, what should be done to make sure that every applicant would be treated fairly and without discrimination, would get service in his proper turn just as soon as facilities became available—and would feel confident that this was the case?

Even if at first the situation were patiently explained to customers, was there a possibility that after many months the feeling might develop among representatives that people ought to know by this time that they couldn't get service, with the result that indifference or even lack of politeness might creep unconsciously into tone of voice or attitude—affecting not only the handling of applications for service but all other types of contacts as well?

Other War-time Problems

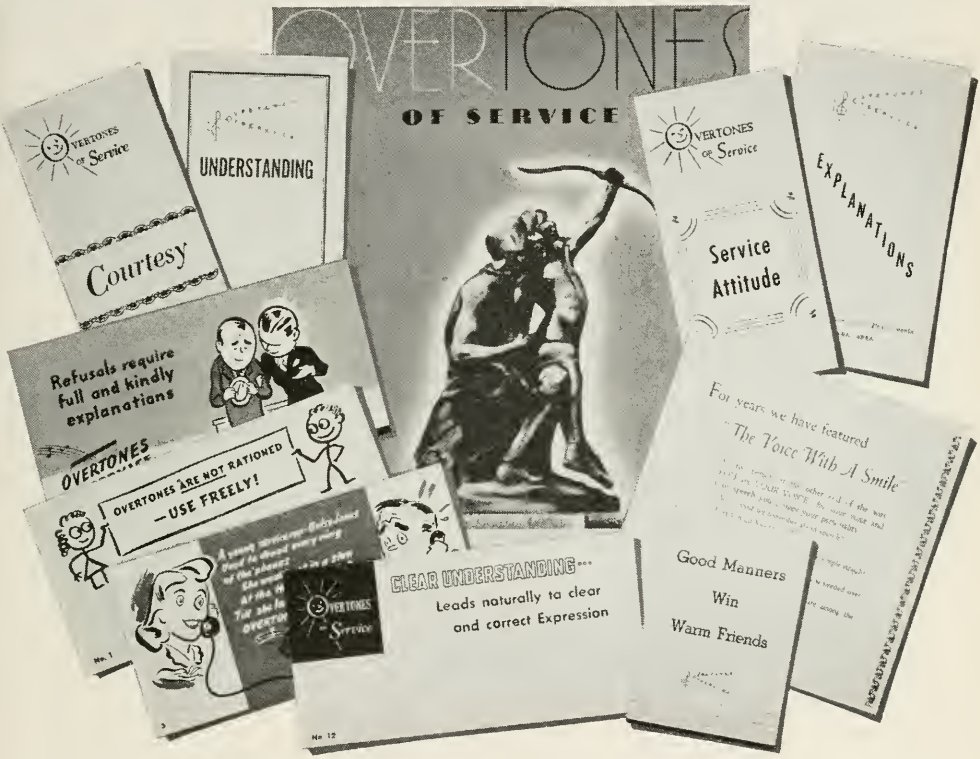
IN A REPORT upon business office service in war-time, there is naturally so much to be said about the problems arising in connection with applications for telephones as to run the risk of losing proper perspective through failure to stress how seriously the impact of war threatened business office service in other respects.

As in the case of most other businesses, the upheavals of war caused force losses, formerly almost negligible, to rise to substantial levels. In many offices, the number of losses was equivalent on an annual basis to a

100 percent turnover in the force and in some places it was substantially greater.

To appreciate the potential effect of this force turnover, it should be pointed out that in order properly to represent the Company to the public, service representatives must possess good judgment and also the ability to absorb a wide range of information in view of the many different subjects arising in contacts with customers, often involving discussion of Company practices and policy.

With this turnover, a training job had to be done which would have been quite time consuming even if it had not been necessary to superimpose upon the regular job the wartime one of telephone shortages and denials. Furthermore, it may be noted that inexperienced representatives need much more supervisory assistance—a requirement difficult to meet at a time when many men supervisors had gone to war.



Various types of material are used in training and discussion and as publicity to help insure that contacts with customers will be well handled

The situation was accepted as a challenge and an opportunity. Everything practicable should be done to give the best possible business office service on all types of contacts with customers. As to

those involving applications for service, there would be two main objectives. One was to insure full compliance with War Production Board orders (L–50 and its successor U–2). The other was to handle applications so as to assure full public understanding of the situation, confidence in the Company's administration and impartiality, and recognition of its continued interest in customers even when it had nothing to sell.

Utilities Order U-2

THE SUCCESS of this policy was most encouraging. When the job was looked at from this viewpoint, it was gratifying to see how much could really be done along constructive lines: so much that seemed so worth while and stimulated pride of accomplishment. The problems that had been regarded as difficulties began to appear in their broader and truer sense as stimulating war-time responsibilities.

Take, for instance, the Government limitation order now known as Utilities Order U–2. No matter whether it was considered from the standpoint of the War Production Board, the telephone industry, or the public, the service representatives really had a most unusual and appealing responsibility in its administration. Theirs was, in fact, a key position as regards compliance, in the education of customers, and in obtaining public acceptance of limitations.

As most customers had no practicable way of becoming acquainted with the terms of Order U–2 until they applied for service, service representatives had a fine opportunity to help in customer education. This required them, in turn, to become thoroughly familiar with the many and changing provisions of Order U–2 affecting customers. To obtain ready acceptance of the terms of the order more had to be done than just to tell customers what they could not have. It was necessary for representatives to understand and explain the underlying reasons for the different provisions.

The opportunity to be helpful was quite marked in the interpretation and application of two provisions of the order. One of these provided for installation of main telephone service despite limitations where its use was essential to "direct defense" or to "public health, welfare, and security," as defined in Schedule A of the order. Instead of simply quoting the language of the order, representatives could do much to assist customers by discussing with them their intended use or need of the service, to see if it qualified for immediate installation under Schedule A. Helping to determine the essentiality of service was no easy matter, in view of the wide variety of conditions under which service is used by seemingly endless types of enterprise; and much tact as well as business judgment would be required on the part of representatives.

THE OTHER provision concerned the right to appeal to WPB in instances where customers felt that inability to obtain service under the Order would cause them undue hardship. Without going so far as to stimulate appeals, representatives could be helpful by bringing the provision for appeal to the attention of customers who wished to claim undue hardship or

to have their case taken further. In cases where customers decided to appeal, representatives could assist them in preparing their case so as to facilitate its review by WPB, to which the company forwards the necessary documents.

The Results

Two and a half years of operation under war-time conditions afford enough experience to warrant commenting upon results. They have been generally gratifying. Business office service is at its best levels, judged by such criteria of technical efficiency as "promptness of attention to customers," "accuracy of information given," and "action taken." The "overtones" of service have never received so much attention, and they reflect it. All the evidence indicates that a conscientious and effective job is being done with respect to compliance with government limitation orders, assistance to customers, and continued interest in them.

There have been some mistakes, omissions, and misunderstandings on the part of business office representatives. While these are no more than might be expected in an undertaking of such magnitude and character, they are all analyzed, none the less, so as to see how to keep them to a minimum.

It is a pleasure to acknowledge how inspiring the attitude of the public has been. People are generally understanding, patient, and coöperative. In war-time they generally seem to become more tolerant, and this in turn surely deserves special consideration. That the public is appreciative of such consideration is evident, and may be illustrated by some examples selected from the hundreds of letters received by Bell System companies.

In connection with applications for telephones, consider the following two letters, the first from a customer in Ohio:

"I don't know much about the telephone business. It has been my impression that when you wrote them a letter, it was a complaint of some kind. Mine isn't.

"I am moving from a one-floor plan house into a two-floor plan and naturally wanted two telephones. I knew I could not get two but that did not stop me from trying. I am only getting one.

"Never have I been turned down so courteously, graciously and tactfully. You are to be complimented on being able to train people to handle the public as this young woman handled me.

"Well, it wasn't necessary to write this letter but it was such an outstanding incident that I couldn't help it. Thank you for reading it."

The following letter is from a customer in Arkansas:

"I want to compliment your organization on the nice manner they say no to a prospective customer. I am a new-comer to the city and being such, I am more or less in the stage where I notice everything. Not long ago, a lady with the phone company called the writer and explained the fact that phone service was somewhat limited and now I have your letter with a more complete explanation. I think it is remarkable management that an organization as large and with as little over-all competition as the Bell Company can maintain con-

sistently such an attitude toward the public in general.

"Of course I still do not have a phone but your attitude is like a fellow scratching a case of itch. 'Makes you feel better anyway.' "

Public Attitude

THIS ATTITUDE is striking in the case of customers who have to wait for main telephone service. Inability to get service is always disappointing and very often entails real sacrifice. Surveys show that lack of service causes real hardship to as many as twenty or thirty percent of applicants. Yet usually fewer than five percent of the customers denied service end their discussion with the business office representative by expressing criticism of limitations or appealing to WPB.

As applications for service account for less than a quarter of representatives' contacts with customers, the question may arise as to whether such employee consideration and public appreciation extend to all types of contacts, including those having to do with billing and collections. The following letter from a New York customer is, therefore, of interest:

"If this letter reaches the girl with whom I've dealt by telephone from time to time about my bill, I want her to know that I appreciate not only her courtesy, which the Telephone Company expects of her, but also her friendliness and good humor. It was a pleasure to deal with her, and I

THROUGHOUT the Bell System, recognition of the importance of the service representatives' war-time job is accorded in various ways—such, for example, as this poster

hope she's assigned to my account again! Thank you for a great deal of good service."

Important factors in the achievement of these results have been the high quality of business office personnel and their spirit of service in accepting responsibility for pleasing and helping customers. How deep this feeling can be, particularly in these troublesome times, may best be illustrated by quoting a New York Company representative:

"At times we may overlook the importance of our daily contact with our customers. It is our job, and we may fail to see the green grass in our own pasture. How can anyone accurately judge the good we have done by listening sympathetically to a customer's story of misfortune? How can anyone judge how much good has been done by an understanding word to an impatient or irate customer whose nerves may be worn thin by personal worry and anxiety? Our part goes further than building customer goodwill—it helps build morale."

Planning Ahead

THE System companies have continued to maintain high standards in the selection of the employees who will represent them to the public, and this has been most effective in maintaining the Bell System "Spirit of Service" in the business offices. The development of this sense of responsibility for service starts with the first interview with a prospective employee, and never ends. It has been continuously stimulated by fostering pride in accomplishment and belief in giving the best service possible.

A very active program has been undertaken by the Commercial managements of the companies to assist their business office organizations. In fact, the resources of the entire System have been mobilized to help in making "estimates" of the situation from time to time, in planning, evaluating experience, and otherwise checking results.

NATIONAL advertising helps customers to appreciate the assistance which the representatives can give

The A. T. & T. Company has, of course, participated throughout: by staff studies, by visits to the companies, by the interchange of experience, by participation in inter-company meetings, and by representing the Bell telephone companies as a group with WPB.

In anticipation of the many problems which seemed likely to arise un-

der continued war-time operation, a series of inter-company meetings was held in the fall of 1942 to discuss plans for strengthening business office management so as to be sure of meeting the test of difficult conditions ahead. Three series of inter-company meetings have also been held to review experience and plan ahead in connection with business office administration under Government limitation orders and the handling of applications for service.

All of these meetings were paralleled by similar meetings within each company which were in addition to their own frequent experience meetings. In this way the experience, plans, and ideas of all the companies were made available for the benefit of each company, each office, and, in fact, each employee in it.

This process of periodic planning ahead, followed later by checks of results, has been most productive. In addition to being carried down the line of organization to each exchange, it covers the activities of the staff groups also.

Training and Supervision

THESE staff groups have made sure, for instance, that the business offices had the benefits of the best training assistance. Initial training procedures have been so improved as to cut down by two weeks the time taken in this training.

Training material has been revised not only to incorporate new or changing information or background, as in connection with Order U–2, but also to promote the discussion of contact techniques. As much study is given to the latter as American sales management is famous for giving to the sales contact. No attempt is made, however, to teach canned contacts or talks; the emphasis is on understanding, point of view, analysis of experience, and the principles of expression.

"Manning" of business offices, or force adjustment, has been given special attention, not only to insure customer satisfaction through prompt attention but also because a rushed feeling handicaps employees in furnishing a service with that high degree of accuracy and "overtones" which is their objective. Additional supervision has been furnished to the extent necessary. In many Companies a new form of business office organization has been introduced and women supervisors assigned to assist the managers. The management of business offices has been strengthened through special training courses, in which a specially developed manual has been used giving the latest experience in the System on the application of the principles of management in business office operations and the maintenance of the best possible personnel relations. All levels of supervision, men and women, from the top of the Commercial Departments down, have participated in this training.

"Overtones"

AMONG the aids to management in the administration of the day-to-day job, one of the most helpful has been the constant analysis of the quality of "contact" service. This analysis has provided the basis for determining what opportunities exist for improvement and what corrective action should be taken. For many years before the war, a rather precise method

of analysis had helped in maintaining the promptness of attention to customers, the accuracy of information given them, and the correctness of any action taken. But while the "overtones" mentioned earlier had also had a great deal of supervisory attention, the apparent difficulty of measuring intangibles was such that not until 1942 was a practical method of analyzing "overtones" developed.

It could not have come at a better time, in view of the unusual need for pleasing and helping customers—especially those applying for service. It focussed attention upon five essential features of good "overtones": "Speech," "Courtesy," "Understanding the Customer," "Quality of Explanations" and "Service Attitude." The standard of judgment used was not to find out what was poor but what fell short of being definitely very good. This approach appealed strongly to the business office personnel and proved to be a highlight of the service maintenance program, stressed in training and inspirational leadership.

Care of Held Applications

A DESCRIPTION of the care taken of the so-called "held applications" of customers waiting for service may be of interest.

Customers have a right to expect that their applications are not overlooked, and will be completed in their proper turn just as soon as facilities are available; and, as mentioned previously, good service requires also that they should be made to feel confident that this will be so. Special provision has, therefore, been made for the care of the held applications. There is a centralized control file for each office, where suitable precautions are taken to insure keeping them in their proper turn and to check them as central office equipment, outside plant, or telephone sets become available.

Since it promotes confidence if an applicant calling up to inquire about his application finds that the representative he talks to has his application readily at hand, duplicates of applications are maintained practically within arm's reach of the representative to whom the calls from that applicant will normally be routed. As additional evidence of care and interest, the companies are generally following the practice of writing applicants at intervals.

THIS ARTICLE is only by way of a progress report on the job done under war-time conditions by Bell System business offices in handling not only applications for service but all types of contacts with customers. It covers operations up to June 1944. The job done cannot be fully appraised at this time. It may well be that the final report cannot be written until facilities are fully available again everywhere, and waiting lists disappear.

While no one can say with certainty what problems lie ahead in customer relations—or limitations—this much is definite: telephone business office people are convinced of the importance of alertness to changing conditions and the value of doing everything practicable to give the best possible service, come what may.

Provision of Pleasant Rest Rooms, Lounges, Cafeterias and Other Quarters for Employees Has an Important Part in the System's Successful Employment Program

Recreation Facilities for Bell System Women

Raymond A. Steelman

LAST YEAR the Bell System hired more than 122,000 telephone operators, and another 28,000 women for other kinds of telephone work. There were more women on the System's payroll in 1943 than in any one of the preceding 65 years of the industry. The hiring of large numbers of women continues.

To employ so many women in that year—and most of them in places where employment conditions were anything but easy—was in itself an accomplishment. By implication, the reputation of the employer just had to be good.

What factors combine to give an employer a good reputation? Among the points which contribute to employees' satisfaction with their jobs are such things as their wages, of course, and their supervisors, their associates, and the environment provided for them by their employer. Ranking high as a reason which attracts people to telephone work, and for continuing in it, are the facilities regularly provided for the convenience and relaxation of the workers: such matters as rest rooms, lounges, and cafeterias.

Thus the System's high standards for such quarters, built up not over night but over the years, play an important part in attracting as well as holding new and much needed workers in the vitally war-important telephone industry. That they are doing so is illustrated in some part by the pictures, from many sections of the country and mainly of pre-war installations, which appear on the following pages.

WAR HAS BROUGHT many new problems to the men and women who are charged with the supervision of these quarters.

So that these facilities, which have such a direct effect upon the happiness and satisfaction of telephone workers in their occupations, may continue to serve their purposes well, it is essential that they be maintained with care and good taste. And in these stressful days, there is more need than ever that the quarters used by the employees during their off-duty periods should not be allowed to become drab.

A Lift to Morale

EVERYONE with a home recognizes the lift to his or her spirits—morale is merely a war-time word for it—that comes from new paper or fresh paint on the walls, gay new curtains at the windows, or even just some colorful new accessories. So it is around a telephone building: when rest room or lounge or cafeteria is redecorated or refurnished, and in a cheerful new color scheme, the employees get a good deal of added pleasure out of the facilities which are theirs to use. Where such things can reasonably be done under wartime conditions to add to the pleasantness of the working days of the nation's telephone women, the effort is well repaid.

By no means all the activity has been concentrated on maintenance of the various quarters which were in existence before the war. A few new central offices have been established where none previously existed, and in them new facilities have been installed. Many offices which were small before the war now have hundreds of operating employees, and quarters which were once adequate have had to be enlarged. Special problems have arisen in connection with providing meals and quarters for several thousands of operators who have had to be "imported" on a voluntary basis in many communities, large and small, to augment the central office forces handling heavy traffic occasioned by large military establishments or war industries nearby, or in some cases to operate the private branch exchanges in Army camps and posts.

Particularly acute have been the dining service problems. Since the System's cafeteria enterprises do a business of nearly $8,500,000 a year —even at their normal low prices—it is not surprising that under conditions of shortages and rationing the administration of the dining service has become increasingly difficult. Getting enough of the right kinds of food to go around, compensating for restricted deliveries from suppliers, obtaining and retaining dining service employees, have been some of the major headaches.

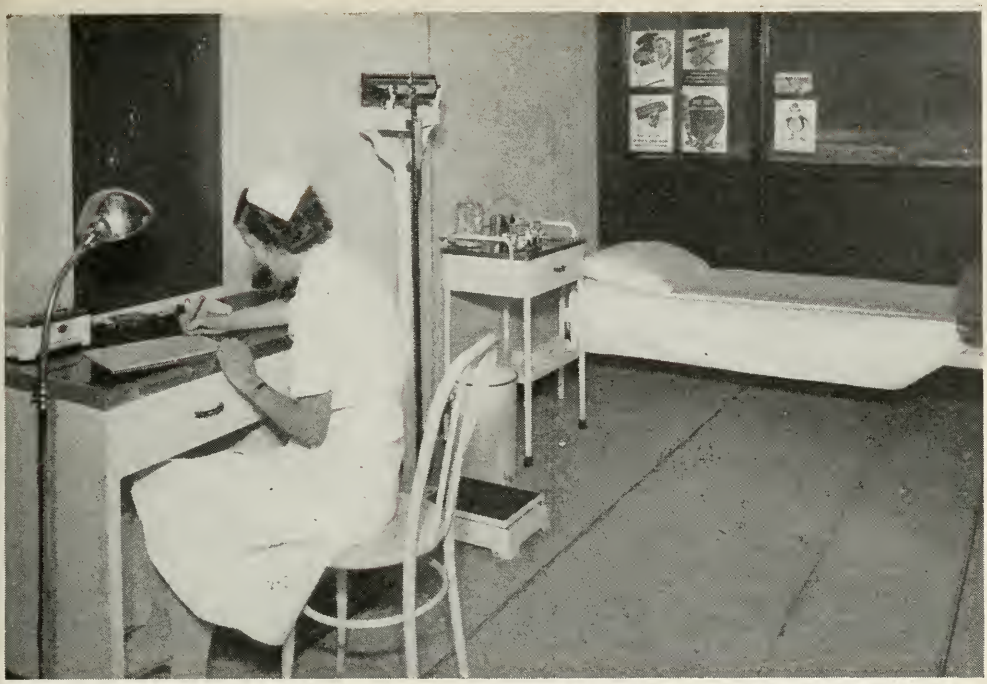
IN SPITE of them, much has been accomplished. A few new cafeterias have been installed and some have been substantially enlarged. Many cafeterias formerly closed on Sundays and holidays now remain open on those days; many are now kept open much later in the evening than formerly; many which once closed at night are open 24 hours a day. Not all the night shifts are at munitions factories and airplane plants; operators play their part in war production too, and the cafeterias give service largely for their convenience.

Quarters' staffs have had to exercise a good deal of ingenuity in making use of what has been available to work with. Some second-hand equip-

Who couldn't relax for a few moments in such pleasant surroundings as these? Comfortable chairs and sofas, current magazines and good light to read them by, telephones, desks and writing materials, and a harmonious decorative scheme are features of the typical lounge for women employees. In some buildings where large forces are employed, separate smoking rooms (below) are provided too.

CONVENIENCES such as those above make it easy to write to friends and relatives in the armed forces. To emphasize the contribution of telephone service to the winning of the war, some companies furnish stationery imprinted with "Serving on the Home Front" or similar phrases. A "powder bar" like the one below is a help to good grooming on the job and when leaving for home or a "date."

FACILITIES for a rubber of bridge or a bout of table tennis are available in some of the large telephone buildings.



In some central offices, particularly those having many operators who are living away from home, a graduate nurse is employed. She helps the chief operator with health matters, is available for consultation or first aid, and visits operators who are ill. A "quiet room" (below) for operators who feel indisposed or who want to rest during lunch or "relief" periods, is an adjunct in many operating buildings.

To HOUSE the operators rendering telephone service at Army camps and at other localities which have mushroomed because of the war, many telephone companies have had to build temporary dormitories or rent large residences such as that above. They include comfortable living, dining, and bed rooms, and are under the management of house mothers who also have supervision of the various social activities.

When the size of the force and the location of the building are such as to justify it, cafeteria service provides meals for employees at moderate prices. Equipment must be modern and efficient and the staff competent to provide economical operation of a pleasing service.

In some large telephone buildings, soda fountains (above) are a popular supplement to the cafeteria counter. In many smaller telephone buildings, facilities like those below enable operators to prepare their own light lunches.

THE LARGE CAFETERIA above is notable for its gay color scheme, attractive counter, and unusual wall treatment. The "nooks" formed by benches placed back to back in the smaller room, below, give it an atmosphere of cozy informality.

A "SNACK ROOM" like that above is sometimes a solution to the problem presented by lack of space for a complete cafeteria in a building with an expanded war-time operating force.

ment of one sort and another has been picked up and reconditioned when necessary, and substitutes have of course been used to good advantage. In one very busy war center, for example, all facilities of the kind under discussion had to be moved out of the telephone building to make room for a greatly expanded switchboard and its associated equipment; so an old brick structure adjoining the central office building was acquired and rejuvenated, doors were cut through, and all the quarters were established in it. Since no other space was available, a cafeteria was set up in what had been the cellar; and while it is not all that might be desired, bright lights, and bright colors on the walls and floor and furniture, give the room a pleasant atmosphere. The service is much appreciated, too, because there is no other place nearby where good food can be obtained.

THE WAR-TIME SPIRIT of the women of the Bell System is high. Many things contribute to this, of course. Among them may be counted, surely, the facilities and the services which this brief account has reviewed. Before the war, the intent was to make them adequate and attractive. The present task is to keep them that way —to the limit that space, labor, materials, and thoughtful ingenuity permit.

When a Circus Burns

Raymond A. Loring

TRAFFIC was moving smoothly in the Hartford telephone office at 2:30 Thursday afternoon, July 6. Outside, heat beat down on the blistering streets—humid heat which made the 90-degree temperature seem more like 100.

Telephone operators on relief sipped "cokes" in the cafeteria and allowed that they were much better off than the folks out at the crowded circus grounds. The Ringling Brothers' greatest show on earth had pulled into Connecticut's capital city the day before, too late for its matinee, so this afternoon's performance had attracted an unusually large number of women and children.

And then suddenly, at 2:40, it was no longer just a hot summer afternoon in Hartford. Through the operating room flashed a message which was to set off the greatest rush of frantic calls ever handled by the Southern New England Telephone Company's biggest office—greater even than any 24-hour load during the disastrous flood of 1936 or the hurricane of 1938:

"The circus tent is on fire—yes, the Big Top!"

It's unbelievable, fantastic. That was the instantaneous reaction. If it were true—but that was too horrible to contemplate.

Prepare for the worst, said the traffic people as they sped the report to the plant department. Still they hoped it was an exaggerated rumor.

That hope was short lived. A plant man who had been watching the performance called in. "Hey, boss, all hell's loose out here. The Big Top's one big blaze. Women and kids are being burned and trampled . . ."

There was no doubt now. Already emergency calls were speeding through the switchboards. Send ambulances. Call all doctors and nurses. Tell the hospitals and Red Cross to get ready for the casualties.

With the speed of the flames which consumed the tent, word of the catastrophe spread through the city. Operators on relief rushed back to their positions. In an unbelievably short time, off-duty girls, operators on vacation, and former employees came on the run, oblivious of the heat. . . . The "spirit of service" is no empty phrase in the Bell System.

Nor is this spirit limited to one group. From the plant department went word to route all telephone cars to the scene to help in rescue work and to establish emergency service. Some picked up nurses on the way. One man helped a hysterical woman and child who couldn't remember what had happened and in their frenzy couldn't find their way home.

Even as the plant men converged on the circus grounds it was hard to comprehend the extent of the tragedy. The shrieks of the dying and injured mingled with the hysterical cries of frightened children and the wails of

ambulance sirens. In little more than half an hour a scene of gaiety became the most spectacular and frightful disaster in Hartford's history. The death toll was to mount to more than 165, the list of badly injured to a larger figure. And for hours to come, the telephone was to be the means of directing relief, answering desperate queries, and allaying the fears of agonized relatives and friends not only in the city and its suburbs but throughout the state and nation.

While the canvas still blazed, plant men ran extra lines into the circus lot and established an emergency telephone center for the use of police, fire, and rescue officials. Commercial representatives were on the spot almost all night to aid those who were placing calls. First to use these facilities was the mayor in directing early phases of relief work. Later these telephones were a real boon to circus people who wanted to rush word of their safety to distant relatives.

Installers were dispatched to the city's hospitals to add lines, and traffic's PBX instructors and commercial people aided the regular operators at these boards to handle the tremendous traffic. PBX repairmen were stationed at these boards, as well as at police headquarters and at emergency installations, to guard against any breakdown in the equipment. Back in the central office, plant men watched for alarms and call blocks in the dial equipment. Two traffic overflow desks were wired and held

EVEN BEFORE the fire was extinguished, an emergency telephone center had been set up and was in use for directing relief work.

for relief of any PBX that might prove unable to handle its load.

Evidence of the Tragedy

A LITTLE MORE than an hour after the first fingers of fire had reached up the side of the big tent, the central office battery discharge, normally 650, was 1150. Emergency Diesel engines, on test that afternoon, were continued in service to augment the regular power. Dial equipment experienced unprecedented loads, but it met the test and no emergency measures for control of dial traffic became necessary.

Up in the block-long operating room was growing evidence of the extent of the terrible tragedy. Every position at all boards was filled; 250 girls were on duty as compared with a normal force of 150. All afternoon and far into the night these girls, many of them new in the business, worked on. There was no thought of supper, no thought of going home. The cafeteria staff made extra sandwiches, more ice cream was brought in—and operators stopped only for a snack.

Despite radio announcements and the publication of information in newspaper extras, thousands of calls requesting all kinds of assistance were received at the toll board and at information positions.

A Toronto, Canada, newspaper wanted an eye-witness account of the disaster; an out-of-state doctor gave some specialized advice; a spokesman for Western Electric employees in New York offered blood plasma to any injured telephone people; a newspaper syndicate wanted a telephoto circuit; another needed teletype connections; and early Friday morning a man telephoned from South America trying to reach his brother who is an animal trainer with the circus.

Coin telephones, especially in the area of the circus grounds, were being used extensively by those trying to locate relatives from whom they had become separated. Others were calling home to say they were safe. As hundreds had come to the circus from surrounding communities, there was also a record volume of short-haul traffic to and from nearby exchanges.

Authorities selected the state armory as a temporary morgue, with the state police in charge. Here a battery of 15 telephones was hastily installed to serve as an information bureau. It was manned by girls from the telephone business office and the plant department. These girls handled an estimated 10,000 calls in 12 hours. Some remained on duty until 3 o'clock in the morning; commercial and plant men carried on all night. Additional trunks were installed at two locations for the Red Cross and at a public school where the hundreds of lost children were held until called for.

EVERY Hartford telephone employee was on the job or assisting at hospitals and relief centers, 47 emergency local circuits were installed, local calls were going through without delay. And then a new problem arose. As news of the catastrophe was featured on the national radio hook-ups and in metropolitan newspapers early in the evening, incoming toll traffic reached new peaks. Southern New England and Long Lines engineers established additional emergency toll circuits to New Haven,

New York, Boston, and other centers, a total of 30 finally being pressed into service.

Because of the thousands of people involved in the affair and the difficulty experienced in identifying the injured and tracing missing persons (some 2,000 were reported missing at various times), there was little let-up in telephone traffic all night. Not until almost noon Friday did the volume assume any semblance of normality.

Appreciation of the work of telephone men and women was expressed by Governor Raymond E. Baldwin in a personal visit to the emergency telephone room at the armory and in a call to the chief operator. Red Cross officials, newspapers, hospitals and others commended the ability of employees to keep their heads and do a good job under unusual stress.

To a shocked and saddened community, Hartford telephone people had shown their understanding in the way they know best; by providing helpful, friendly service.

"Electronics—Today and Tomorrow"

John Mills, Director of Publication at the Bell Telephone Laboratories, is the author of a new book, published by D. Van Nostrand Company, which bears the title quoted above. Mr. Osborne, who contributes the following review, is Chief Engineer of the A. T. & T. Company.

Electronics, except in name, is an old friend of telephone people. For many years electronic devices, particularly the three-element vacuum tube, have been basic in many of the advances which have kept the United States in the lead in telephone service, both by wire and by radio. Electronic tubes were used in establishing telephone service across the continent 30 years ago. They were an essential element in the first transmission of speech across the Atlantic 29 years ago.

Electronic tubes have been used for so many years and in such great numbers in the telephone plant that telephone people in general no doubt recognize their old friend in spite of the emphasis which is now being given to its new name. Many people in the telephone industry must have been amused by the slogan featured currently in the advertising of one manufacturer: "Every radio set made by ——— is an electronic device." In the broad sense in which the term is often used today, we might well say that every telephone conversation is an electronic phenomenon. Even in the narrower and perhaps more legitimate sense in which the author uses the term, as applying to tubes having a high vacuum or low gas pressure,

practically every long distance call makes use of electronic tubes.

The telephone man or woman who knows the importance of electronic devices in the telephone business, and desires to have a general idea of how they work, will find Mr. Mills' book, "Electronics—Today and Tomorrow" made to order. Mr. Mills undertakes to describe the phenomena of electronics in terms which are intelligible to the layman having some knowledge of physics. Although the subject matter is in the field sometimes referred to as modern physics, the phenomena are described to a surprising degree in the terms of classical physics: mass, velocity, electric and magnetic fields, etc. The structure of electronic devices is, however, very novel; and the attempt to describe how these structures work in a qualitative way in terms which are intelligible to a layman is a formidable undertaking. The undertaking is all the greater as Mr. Mills has chosen to do this without illustrations, except for the suggestive little sketches at the chapter headings.

Mr. Mills has done a remarkable job in his description. I think, however, the layman who reads the book would do well to renew at least a speaking acquaintance with his freshman physics, if he has allowed that acquaintance to lapse.

Reference has been made to the great application of electronic devices to telephony during the past thirty years. During that period, applications have been made also in many other fields: the radio broadcasting industry has been built upon electronics, electronic devices are used for all sorts of control operations, and during the past few years the military applications have been of great novelty and importance. Mr. Mills' brief references all the way through the book to current applications of importance add a great deal of interest to the lay reader. It is not a book specifically for telephone men. It is of interest to all who would like to acquire a general knowledge of this fascinating field of science.

HAROLD S. OSBORNE

Sound Movies for Sound Education

This account of the present status of Erpi Classroom Films, taken in part from The University of Chicago Magazine, *is by William Benton, Vice President of the University.*

UPON the recent acquisition of Erpi Classroom Films Inc. by the Encyclopaedia Britannica, Mr. Hutchins [President Robert M. Hutchins of the University of Chicago] said that through classroom films the Univer-

sity of Chicago has perhaps a greater chance to influence American education in the next twenty years than through all the rest of its activities put together. President Hopkins of Dartmouth seven years ago compared the coming development of the classroom film with the invention of printing. For decades many men in education and outside of it have agreed that in the classroom film lies the potential of an educational revolution. America has had entertainment moving pictures for almost half a century. Why, then, have so few films suitable for the classroom been produced and distributed to the schools?

FIRST, producers who have known the techniques of production have not correlated their knowledge with the knowledge of educators. This is in part due to the resistance of the educators. Educators, like other people, will resist anything which compels them to change their habits. Educating the educators is perhaps the longest of all educational jobs.

A more important reason, perhaps, is the nature of the moving picture industry. The big companies have not known good instructional films from bad ones. They have always concentrated on the quick-profit opportunities in entertainment pictures. The two fields are entirely different, as different as a textbook on physics and the *Saturday Evening Post.* Only one company has produced instructional films in collaboration with educators. This company has been a wholly owned subsidiary of the American Telephone and Telegraph Company.[1] It is Erpi Classroom Films Inc. E-R-P-I stands for Electrical Research Products Inc.

In 1932 the University of Chicago started to produce classroom films through a contract with Erpi. These were the first talking films produced on any university campus. During the past twelve years forty University of Chicago films, made specifically for the general courses in the College, have been produced under this contract, with the result that our faculty has learned more about making classroom films than any other faculty has had a chance to learn.

Since 1930 the phone company has invested more than $3,200,000 in Erpi Classroom Films.[2] The company is small, but it is the giant of its field. Perhaps two thirds of all the films shown in the classrooms of the country today are Erpi Classroom Films. These films are made for all school grades, from nursery school through college. Some of the college films, incidentally, are shown successfully as low as the sixth grade. The so-called "library" of Erpi films now exceeds two hundred in number, all designed for use by the teacher, all integrated with existing curricula, and all produced in collaboration with educators at various institutions.

THESE FILMS do not go out of date. Some films made nine and ten years ago are selling better than other films made last year. The films average about eleven minutes in length. Dozens of scholars often collaborate in the making of just one film. They are made to be shown *after* instruction by the teacher, *after* textbook and laboratory study, and they are

[1] Erpi Classroom Films Inc. was owned by Electrical Research Products Inc., a subsidiary of the Western Electric Company.—*Ed.*

[2] The investment was made by Electrical Research Products Inc. out of profits from other motion-picture activities.—*Ed.*

shown *again* and *again* to the same students during the course of the year's instruction.

Mr. Hutchins, believing that the development of classroom films should be in the hands of educators, made his first effort to wean Erpi Classroom Films away from the telephone company in 1937, the year I joined the University. One of my first assignments was to work with Mr. Hutchins, and with Nelson and Laurance Rockefeller, on a presentation to the Rockefeller Foundation urging the acquisition and development of Erpi Classroom Films. As far back as this, A. T. & T. itself frankly conceded that it could not do justice to this field; its position as a big utility company forbade the development of needed films in the social sciences. Economics, sociology, and political science involve controversial material that the phone company could not risk.

Following the gift of the Encyclopaedia Britannica to the University by Sears, Roebuck and Company a year ago, Mr. Hutchins wrote Mr. Gifford proposing the gift of the Erpi Classroom Film company to the University of Chicago. Reticence is not a valued characteristic in university presidents. Out of this letter grew a fifty-four page printed contract by which the Encyclopaedia Britannica has purchased Erpi Classroom Films through an issue of debentures, representing the book value of Erpi, to be retired over a period of years out of profits of the Encyclopaedia Britannica, and, it is hoped, out of profits from classroom films.

The management personnel of Erpi Films will continue unchanged under Britannica's ownership, and selling and pricing policies will continue as in the past. The association of Erpi with the University will make fully available the broad knowledge and pedagogical skill of the University staff and should result in an expansion of production of films for classroom use and perhaps of extracurricular films for use outside the classroom.

Picture Credits

PHOTOGRAPHS illustrating Gen. Ingles' article were obtained from the following sources, reading from top to bottom and left to right on the pages numbered:

70—Signal Corps from Acme Newspictures, Signal Corps (middle and bottom)

72—U. S. Navy (top and bottom), Army Air Force

73—Acme, International News, U. S. Navy

74—Signal Corps, War Pool from Acme

76–7–8—Signal Corps (all)

80—Signal Corps (top and lower right), Acme

82—U. S. Navy, Marine Corps, Coast Guard

84—Signal Corps (top and bottom), U. S. Army from British Combine

86—War Pool from Acme, Signal Corps from Acme

87—Marine Corps, International, Signal Corps

88—Navy from Acme, Acme, Signal Corps

90—Army Air Force, Army from British Combine, Signal Corps

For the Record

A selected list of happenings, of System interest, occurring between May 1 and July 31, 1944

At the regular meeting of the Board of Directors of the A. T. & T. Company held on May 17, a quarterly dividend of $2.25 a share on capital stock was declared payable July 15 to stockholders of record June 15.

The War Production Board on May 19 authorized the manufacture of 800,000 telephone sets for civilian use. Permission to resume manufacture was largely due to the decision of the Western Electric Company, which will make about 80 percent of the total number, to move machinery and equipment from its Hawthorne and Point Breeze plants to St. Paul, Minn., where labor is readily available. It is not expected that actual production of a substantial number of new sets will begin before the last quarter of the year.

The "D-Day" announcement of the Allied invasion of the coast of France on June 6 was transmitted to this country over a transatlantic radio telephone hookup. Plans had previously been made by the Army, with the coöperation of the Long Lines Department, for the handling of just this situation; and twelve minutes after the Army had given advance notice that an important announcement would be made from London, the words of historic Communiqué No. 1 came over the air from England. All principal broadcasting and news agencies in this country were able to hear them. Brigadier General Frank E. Stoner, Chief of the Army Communication Service, sent a commendatory letter to the Long Lines Department for its handling of overseas communications on D-Day.

The A. T. & T. Company received FCC authorization on June 20 to build experimental radio stations in New York and Boston for a wide-band point-to-point repeatered radio telephone circuit capable of operating simultaneously in both directions between the two cities. (See "The Bell System's Interest in Program Television," Magazine, Spring, 1944.)

A "Certificate of Appreciation" was presented to the A. T. & T. Company by Major General Harry C. Ingles, Chief Signal Officer, A. U. S., on June 23. The ceremony took place in the lobby of the Headquarters building at 195 Broadway, and President Walter S. Gifford made the address of acceptance. (See frontispiece of this issue and quotation on page 71.) Although others have since been presented to a number of communications companies, this was the first such certificate to be presented to a telephone organization.

Commissioner T. A. M. Craven retired from the FCC at the expiration of his term on June 30.

July 5 marked the fortieth anniversary of A. T. & T. President Walter S. Gifford's service in the Bell System. He started as a clerk in the payroll department of the Western Electric Company in Chicago.

Revisions of Utilities Order U-2 were issued on July 17 by the War Production Board. Principally, the changes add some flexibility to plant operations by removing direct limitations on drop and block wire and exchange line plant, and provide additional categories of preference, Schedule B and Schedule C, in completing residence service applications in certain cases.

James W. Hubbell, President of the New York Telephone Company since 1941, died on July 20. On July 26 Carl Whitmore, Operating Vice President of the Company since 1941, was elected to succeed Mr. Hubbell.

It was announced on July 25 that rates for overseas telephone service to Argentina, Brazil, Chile, Peru, Colombia, Puerto Rico, and Haiti were to be lowered generally, beginning on August 1.

me XXIII Number Three Autumn 1944

Bell Telephone MAGAZINE

Address before the U. S. Independent Telephone Association • WALTER S. GIFFORD

"I Knew Then I Was Home" • BURTON A. HOLLINGSWORTH

For Heroism, Gallantry, or Extraordinary Achievement • DONALD S. BRIDGMAN

The Rôle of Electronics in Telephone Service • AUSTIN BAILEY

A Hurricane Strikes Again • JUDSON S. BRADLEY

Frank Baldwin Jewett: An Appreciation • ROBERT W. KING

The World's Telephone in War-time • KNUD FICK

erican Telephone & Telegraph Company · New York

Bell Telephone *Magazine*

Autumn 1944

An Address before the U. S. Independent Telephone Association, *Walter S. Gifford,* 137

"I Knew Then I Was Home," *Burton A. Hollingsworth,* 147

For Heroism, Gallantry, or Extraordinary Achievement, *Donald S. Bridgman,* 157

The Rôle of Electronics in Telephone Service, *Austin Bailey,* 172

A Hurricane Strikes Again, *Judson S. Bradley,* 183

Frank Baldwin Jewett: An Appreciation, *Robert W. King,* 200

William P. Banning Retires, 203

For the Record, 204

The World's Telephones in War-time, *Knud Fick,* 205

"The ideal and aim of the American Telephone and Telegraph Company and its Associated Companies is a telephone service for the nation, free, so far as humanly possible, from imperfections, errors, or delays, and enabling anyone anywhere to pick up a telephone and talk to anyone else anywhere else, clearly, quickly and at a reasonable cost."

A Medium of Suggestion & a Record of Progress

Published for the supervisory forces of the Bell System by the Information Department of American Telephone and Telegraph Co., *195 Broadway, New York 7, N. Y.*
Walter S. Gifford, *President;* Robert H. Strahan, *Secretary;* Donald R. Belcher, *Treasurer*

Who's Who & What's What *in This Issue*

During his four decades with the Bell System—the anniversary was last July—Walter S. Gifford has seen the common interests of that System and the so-called independent telephone companies increasingly recognized, and his address which is this issue's leading article is both a contribution to and testimony of the present coöperative state of affairs.

It took Mr. Gifford just under 21 years to go from payroll clerk in the Western Electric Company to the System's top job: President of A. T. & T. Company—even with time out for an important part in World War I in civilian executive capacities. More than twenty-five years later, in this war, he is Chairman of the Industry Advisory Committee of the Board of War Communications.

Concerning Mr. Gifford's many charitable, educational, and scientific interests it is perhaps sufficient to cite that a few years ago he received the gold medal of the National Institute of Social Sciences in recognition of his services "as Director of the Council of National Defense; President of the Charity Organization Society of New York [now the Community Service Society]; Trustee of Johns Hopkins University, General Education Board, Carnegie Institution of Washington; Director of the President's Organization on Unemployment Relief; President of the American Telephone and Telegraph Company, the greatest non-governmental organized service in the United States; and as trustee of numerous educational and scientific foundations."

Telephone people ought to get a lot of heartwarming satisfaction out of knowing that the service they provide can do so much to buck up the wounded fighting men who are returned to this country for hospitalization. Since early last year, Burton A. Hollingsworth has been spending much of his time in visiting Army and Navy hospitals—and sites for them—all over the country and in taking counsel with Bell System companies about both general

Walter S. Gifford

Burton A. Hollingsworth

Donald S. Bridgman

Austin Bailey

Judson S. Bradley

principles and particular services which may contribute to the ease and the satisfaction of the calls which mean so much to the hospitalized servicemen. Mr. Hollingsworth entered the traffic department of the Indiana Bell Telephone Company in 1929, and transferred to the commercial department in 1931, where he served in various capacities. In 1942, while he was district commercial manager in Muncie, he moved east to join the sales and servicing section of the A. T. & T. Company's O. & E. Department.

PRIDE and gratitude must be the emotions of Bell System men and women on the home front toward *all* their colleagues in the armed forces. What must be their feelings, then, toward those who by bravery or special achievement have won military recognition and decoration—often at the cost of their lives? Theirs is the story—or as much of it as is possible within the limits of a MAGAZINE article—which DONALD S. BRIDGMAN tells, letting the actual words of the citations speak in sentences more impressive than those which any civilian would be likely to write. Joining the Ohio Bell Telephone Company in 1920, Mr. Bridgman transferred to the A. T. & T. Company a year later. Since then, in the Personnel Relations Department, he has been concerned with technical and staff employment and related personnel matters. Since Pearl Harbor he has worked closely with System companies on the Signal Corps Affiliated Plan and other military service matters. His "Skilled Manpower for the Signal Corps" was published in the September, 1943, issue of this MAGAZINE.

A NATURAL popular interest in war equipment and a good deal of recent indiscriminate advertising have combined to bring about in the public mind a rather general misconception of what is included in the word *electronics*. Far from being some recent and spectacular discovery, the science of electronics is an old acquaintance of telephone people—as AUSTIN BAILEY makes easily understandable in this issue.

Before joining the Bell System in 1922 he had acquired both A.B. and Ph.D. degrees, and experience in the Signal Corps in the last World War, in private industry, and as a college professor. Since then he has been a member of the Departments of Development & Research and Operation & Engineering of the A. T. & T. Co., and of the Bell Telephone Laboratories, and spent a year in England and Scotland in connection with establishing the first commercial transatlantic radio telephone circuit. He is regularly concerned with the technical aspects of numerous radio projects.

(*Continued on page 208*)

THEIR first and quickest link with home and family: telephone service in Army and Navy hospitals for returned servicemen. The expressions on the faces of these men, as they place their calls with the telephone company attendants and wait for the connections to be established, tell something of the emotion with which they wait to hear the voices of their loved ones. See "I Knew Then I Was Home," which begins on page 147

Furnishing the Best Telephone Service in the World Is A Joint Responsibility, the Head of the Bell System Tells The Independent Telephone Association

An Address

before the United States Independent Telephone Association

Walter S. Gifford

I LIKE the thought that must have prompted the United States Independent Telephone Association to invite the President of the American Telephone and Telegraph Company to address its annual meeting. You and we of the Bell System are jointly responsible for the fact that our great country has the best telephone service in the world and we cannot do otherwise than help further this coöperative undertaking by exchanging ideas freely. I therefore appreciate the invitation and I am most happy to be here.

It is customary for a speaker situated as I am to picture the virtues of the audience and praise its achievements. And this I can do with the greatest sincerity. But I cannot do it in a disinterested manner, for except for the members of the Association there is no one more deeply interested in your success than I am. In the first place, I have a pride in the service the telephone industry as a whole renders the people of the United States. In the second place, I have great confidence in the relationships of your group and the Bell System in rendering this service because the relationships have grown up naturally and are based on long experience. And in the third place, you as well as we in the Bell System are always searching for better ways to do the telephone job and thereby stimulating progress in the whole industry.

As the Telegraph Centennial this year has reminded us, the era of successful electrical communication began just a hundred years ago when Samuel F. B. Morse tapped out the first telegraph message from Washington to Baltimore.

It is a curious coincidence that early

This is the text of an address before the annual convention of the U. S. Independent Telephone Association in Chicago on October 11, 1944.

in 1844, just a few months before Morse sent his message, the United States Commissioner of Patents (Henry H. Ellsworth) had said:

"The advancement of the arts from year to year taxes our credulity and seems to presage the arrival of that period when human improvement must end."

Not only Morse's achievement, but the whole course of the communications industry in the hundred years since then would confound the Commissioner if he were alive today.

The Philosophic Approach

Ralph Waldo Emerson, who was not a scientist but a philosopher, had a shrewder appreciation of the scientific revolution of the 19th century. About five years before the telephone was invented he noted in his journal, "In my lifetime have been wrought five miracles . . . which have altered the relations of nations to each other." One of the five was the telegraph—the others were the steamboat, the railroad, the photograph, and the application of the spectroscope to astronomy.

We can be pretty sure that if Emerson had made this notation in his journal after the invention of the telephone, instead of before, he would have included the telephone along with the telegraph as one of his miracles. Notice also that to him the significance of all these developments was not in the technical achievements they represented, but in the fact that they had "altered the relations of nations to each other." In other words, he was interested in their use and in the tremendous effect of their use upon the world.

The need to communicate with others is one of the instinctive needs of man. Yet up until the time when electricity was first successfully employed to carry men's messages, astonishingly little had been accomplished to speed the process. Broadly speaking, the methods of thousands of years ago were also the methods of one hundred years ago. Any message that had to go a great distance had to be carried. True enough, there were ways of relaying signals—through the beating of drums, the flash of blinkers, the sending of smoke signals, the use of semaphores, and the like. All these systems, however, were limited in scope. The runner at Marathon still had his counterpart, more than two thousand years later, in the riders of the Pony Express. Communication was hinged to transportation, and the acceleration of communications was dependent on progress in transportation.

In our own history there are famous instances, familiar to all, of what delays in communication could mean. On December 24, 1814, the Treaty of Ghent, ending the War of 1812, was signed. However, news of the event had to be carried by a sailing vessel and did not reach the United States until the following February. Meanwhile, many lives had been needlessly sacrificed in the bitterly contested battle of New Orleans, fought on January 8, 1815.

Before the invention of the steam locomotive, transportation, and hence communication, was far from rapid. It has been said that in the 18th century "it took as long to travel by land from Charleston, South Carolina, to Boston as to cross the ocean to Europe, nor was the journey less

dangerous," and that meant more than two months.

As explorers and settlers moved westward, these conditions were repeated in vast areas fronting the Pacific. For some time the only land communication with regions on the west coast was by Overland Mail stages and later by Pony Express. During debate in Congress as to whether the Oregon country was to be brought under the American flag, one nay-sayer objected that it would take a Congressman from that section half of his two-year term in getting to Washington, and the other half in getting back. That may have been a slight exaggeration, for purposes of debate, but it does help to dramatize the communication situation that existed before electricity came to the rescue.

After this long history of slow progress, it seems almost as if the advent of electrical communication had released a long pent-up wish of man which had been intensified through the centuries. Ever since the basic means of transmitting words and speech electrically were first established, more and more use has been made of them; and the continuous search for facilities and methods to increase the availability and speed of world communications has been fully justified by the eagerness of mankind to use each practical new development.

There is no reason to suppose that people will change in this respect. Because the progress of the telephone industry is founded on a basic human need, we have every ground for thinking that the years ahead will give as much opportunity for achievement as have the years since the telephone was invented. On the technical side, as a matter of fact, we already have useful new knowledge which we are only awaiting the end of the war to apply. Developments in the art present and will continue to present new opportunities.

Our Common Problems

But if we have our opportunities, we also have our problems. Let us consider, for example, some of the problems we face as competitors with other industries.

Because two telephone systems in the same town are a nuisance and costly to the telephone user, practically all such duplication has been eliminated, and it is generally supposed that there is no competition in the telephone industry. However, although competition in the ordinary sense of the word does not exist within the industry, there is plenty of competition to spur the industry on. Apart from the most obvious forms of competition with the telegraph and the mail, the industry competes with all other industries for labor, for management, for capital, and for its share of the consumer's dollar.

If the telephone industry is to continue to be successful and to grow, it must continue to be an attractive industry to work in—young men and young women must feel that it offers an opportunity for a good living with agreeable working conditions and for advancement if merited. In this respect the telephone industry competes with all industry and it is vital that it keep well out in front in its appeal to labor if it is to continue to be successful.

Next, as to management, one of

the quickest ways for the industry to become moribund is to fail to offer to management equal or better opportunities than any other industry. Why should a free American citizen who has the ability to manage a telephone company, or a department of it, choose to stay in that job when some other industry offers more? I realize that there is a real intangible appeal in the telephone industry besides the appeal of financial reward. However, in a private industry such as the telephone, I believe that in the long run the management jobs must pay what other successful industries pay; otherwise, the telephone industry will ultimately suffer—and suffer severely.

The Need for a Fair Return

We must likewise compete for new capital as it becomes needed. To furnish telephone service requires a lot of physical equipment which must be paid for—thus the capital requirements are heavy and every added telephone means still more capital investment. The telephone business must earn, year in and year out, enough so that those with capital to invest will want to put it into this industry. Certainly here we have lively competition for the investor's dollar; and right here we are confronted with the problem of regulation. Prices for telephone service are very properly regulated, but they must be adequate to pay all the costs involved in giving good service. These costs include, besides wages, salaries, taxes, depreciation and other expenses, the return on investment. We in the industry must convince regulatory bodies that it is against the public interest, and against the interest of the telephone users in particular, to be so niggardly on this question of return that the financial soundness of the industry and its ability to secure the necessary funds for investment are weakened. Certainly we can't succeed unless our earnings are comparable to those of other industries. This applies not only to the larger telephone companies but also to those companies where the manager and owner is one and the same. The telephone industry belongs to Main Street. It depends for its equity capital upon the people of moderate income who are looking for a sound investment. It is widely owned. There are over 660,000 stockholders of the American Telephone and Telegraph Company, with no stockholder owning as much as one-half of one percent of the total stock, and there are many thousands of stockholders and owners of other telephone companies. This widespread public ownership, including as it does many tens of thousands of employee stockholders and owners, seems to me an added reason why a niggardly attitude by regulatory commissions on rate of return would be against the public interest.

Fortunately, by and large, telephone service is worth a great deal more than it costs. And the effect of being able to give a service that is worth more than it costs is to keep the business in a healthy state of growth. This in turn has helped the standing of the industry with investors. Of course, the reason why the service is worth so much more than it costs is that service has been improved and at the same time costs

have been reduced through the efficiency and skill of employees and through able management and through scientific research.

Our Rural Customers

THERE is one group of telephone users, however, that it is difficult to furnish with telephone service at a price that the customer feels he can pay. I refer to rural telephone service. Here we have great distances to be covered with few customers. Not only the construction required but the maintenance of equipment makes it difficult always to bring the cost down so that the farmer, unless he is a fairly prosperous one, will cheerfully pay the price. Too many of them decide to do without the service. I say this in spite of the fact that rural telephone service is undoubtedly more highly developed in this country than anywhere else in the world. The point is that it is not developed as far as we in the industry would like to have it. As a post-war objective, I suggest that the entire industry unite on the problem of finding ways and means to furnish satisfactory telephone service for the farmer at a cost that more of them can afford. Fortunately, there are developments in sight that make it look as if this could be done.

We have long recognized that because we deal with men's messages, which are the expression of men's thoughts and often of their most important and urgent needs, we occupy an unusual position of public trust. There is a type of telephone business which I am sure all of us will agree we do not want; that is the telephone business that comes from book-makers or others who use their telephones for an illegal purpose. However, I am sure I speak for the entire industry when I say that we feel strongly that it would not be in the public interest for telephone companies to establish a censorship over millions of telephone conversations in order to prevent such use of the service. There is traditionally a confidential relationship between the employees of the telephone company and its customers that it could not possibly be in the public interest to destroy. The regulatory laws under which the telephone companies operate recognize this. They contain many provisions to insure privacy in communications by telephone and they require the companies to give service without discrimination. It is one thing to cooperate with law enforcement agencies by discontinuing telephone service immediately at any address where law enforcement authorities tell us that the service is being used for an illegal purpose; it is quite another thing and, I believe, in the public's point of view a dangerous thing, for us to assume the function of law enforcement itself.

I HAVE referred to our position of public trust and to the tradition which keeps the relationship between the employees of the telephone company and its customers a confidential one. It is a vital principle of our business that telephone men and women do not listen in on conversations and divulge them to others. This brings me to a matter that may turn out to be of real concern to the entire industry. The war has stimulated the use of devices by which telephone conversations are recorded. There are a number of perfectly legitimate uses for

such recordings. If, however, such a practice should become universal, it seems to me it would completely change the character of telephone communications and would be against the public interest. When a person telephones, he very properly expects his conversation to be private. I think consideration should be given to ways and means by which the legitimate use of such recording devices may be continued but all other use discouraged. Some method that would put the unsuspecting telephone user on notice that his conversation was being recorded might perhaps be the answer.

The Test of War

I HAVE mentioned a few of the problems our industry faces. There could be no better ground for assurance that we will meet these and other problems successfully than the industry's record of achievement in meeting the supreme test of war. After what has been done in the last few years, it seems to me we ought to have a lot of confidence in our ability to take on whatever comes next.

In reviewing the war job, I think I can put the essence of the telephone industry's accomplishment in a very few words. We in the industry were and are the custodians of a service absolutely vital to successful conduct of the war. The American people looked to us to provide, on short notice, a greater quantity of swift and reliable telephone communication than had ever been provided before. We have delivered that service, and we shall continue to do so.

Today the telephone industry is serving some 26,500,000 telephones in the United States, or about 5,000,000 more than in 1940, when the national defense effort began. But that is only the broad background of the wartime picture. Let me sketch in a few of the high lights, very briefly.

Of first importance are our services to the Army and Navy and other war agencies. In the last few years service has been provided, usually on a rush basis, to approximately 3,300 camps, bases, arsenals, shipyards and Government-financed war plants. Many of these establishments are of vast size and many are located in cornfields or other remote areas, so that it was necessary to build the telephone facilities from the ground up. In doing this, time was of the essence, and telephone people worked day and night to speed construction of connecting lines, to build and install PBX and station equipment, and to enlarge or build new central offices in record time.

NOT A FEW important toll construction projects were also rushed through expressly or primarily for war purposes. Thousands of miles of private-line telephone and teletypewriter networks were laid out to serve the armed forces. Extensive and flexible facilities were established time and again for the maneuvers of armies in training. Jointly with the armed forces and civilian defense authorities, the telephone industry assisted in creating this country's air-raid warning system—the first line of defense against enemy attack. Many of our land communication lines, together with our overseas radio telephone facilities, form a vital and integral part of the world-wide military communication system which coördi-

nates America's war enterprise over the whole face of the earth.

All this was in addition to the job of giving good telephone service to the privately- and government-owned war industries of the nation, which likewise required an enormous increase in the communication facilities at their disposal. This over-all demand was reflected most clearly in the spectacular increase of toll and especially long distance service. In three years' time the volume of traffic over the longer routes more than tripled, the growth of long distance in the war period almost equaling the entire previous growth through a period of more than half a century. In handling this enormous volume of business, telephone plant has been overloaded and not every call has gone through as quickly as we would like. Nevertheless, important calls have been promptly put through and the average speed of service on all calls has been well maintained considering the extreme difficulties which we have had to face and are still facing. Only a small proportion of all long-haul calls—about seven percent—have required more than ten minutes to complete. This record shows that when the nation turned to the telephone for speed, the telephone industry delivered the service that helped to deliver the goods.

The problem was not merely to meet all essential needs for telephone service, but to meet them during a time when shortages of materials were becoming progressively more acute. Anticipating severe shortages of materials needed for war, the telephone industry voluntarily put into effect a broad conservation program which included substitution of less critical for more critical materials throughout the telephone plant. When the time came for the application and administration of Government orders framed to promote the utmost conservation of materials and manpower, the industry had already gained an experience which has been of great value in enabling us to cooperate most effectively in the Government's program.

Progress made in past years, plus resourcefulness in the pinch, have brought about this two-fold result: the telephone service the nation needs is being rendered, *and* the materials that had to be saved have been saved. Thanks largely to the development of modern telephone carrier systems, millions of miles of toll and long distance circuits have been provided—not all we need, to be sure, but a large amount nevertheless. In particular, the emergency narrow-band carrier channels which we have been able to establish—virtually making two circuits grow where one grew before—have added immensely to our long distance circuits. These circuits have given acceptable service to war-time users without requiring appreciable expenditure of materials. A system of priorities on toll calls established by the Board of War Communications has been effectively administered and has helped to insure swift transmission of important war calls.

Meeting Service Men's Needs

An important phase of the telephone industry's war job is to enable members of the armed forces to make the personal calls which mean so much to them and to their families and friends at home. The entire in-

dustry has done and is doing its utmost to provide service that will be as convenient, personal, and friendly as it is possible to make it. To that end attended telephone centers have been established at hundreds of camps, bases, and hospitals, as well as at many other locations where service men and women congregate. Camp telephone managers and public telephone people are doing everything in their power to minister to the comfort and convenience of all members of the fighting forces who look to them for help. Attendants and operators who handle the calls are eager to render service that will be as distinguished for its sympathetic human quality as for its technical excellence. Engineers are alert to provide the best physical arrangements that can be devised, as for example at military and naval hospitals, where special equipment is often needed for the convenience of wounded or convalescent patients.

Army and Navy authorities from the begining have understood the importance of these efforts and have given us their most helpful and welcome coöperation. I don't think we can possibly overestimate the value of this job, or the extent to which the men and women who use the service appreciate it. And I am very sure that every one of us in the industry regards this assignment as not merely a responsibility but a privilege of the highest order.

Manifesting a Fine Spirit

It seems to me also that the spirit shown on this assignment reflects the fine spirit of courtesy and helpfulness that telephone people throughout the industry have demonstrated in the face of all war-time difficulties. There are a lot of things that I take pride in as a telephone man. There is nothing I am more proud of than to be a member of a group of people who have kept their heads, their tempers, and their good manners. Telephone employees have been confronted by any number of harassing problems. They have had countless rush jobs to perform. They have had more calls to put through than the facilities available were designed to handle. They have had the difficult job, over and over again, of saying "No" to customers. They have had to master all kinds of complex administrative details. They have had to exert all their ingenuity and, at the same time, all their patience. They have done all these things and they have not for one moment slackened in their wish or their ability to render genuinely helpful, courteous service.

This achievement has not gone unnoticed by the American people and I do not believe I am exaggerating when I say that the example of a great service industry continuing to give service with courtesy as well as with competence all through these war years has been a great national asset.

The results which have been achieved could not possibly have been brought about except by the ready coöperation of all concerned, including your group and the Bell units in the industry, the Government groups in Washington charged with war-time administrative responsibilities, and, last but not least, the American people, who have been widely informed of the industry's problems and have

demonstrated their understanding, their patience, and their willingness to help. The spirit of coöperation within the industry has never been better exemplified than in the work of the joint industry committee which has patiently and thoroughly studied our common problems and has made, in my judgment, the most practical recommendations that could have been made to the responsible administrative agencies of the Government.

The present extreme shortage of local facilities for civilian use, as demand for telephone service continues to increase, is the direct result of another vital war job which has been largely entrusted to our industry. I refer to the production of electronic and communication equipment for the fighting forces, in which all manufacturing units of the industry are now or have been deeply engaged. The science behind electrical communication lies at the very heart of modern war; the knowledge of telephone scientists and engineers and the manufacturing skills that we have acquired are indispensable resources, and are directly responsible for the production, in huge quantity, of many of the indispensable tools of victory.

A "Telephone-run" War

THIS is a telephone-run war, from the production plants up to the front lines, on land, on sea, and in the air.

The radio telephone, according to one expert on naval affairs, has brought about a complete change in the conduct of naval war. That is largely because the sea commander can now dispose his forces wherever he chooses across the broad area of battle, summoning them together for sudden attacks. Using short-range voice radio, he can do this without being overheard by the enemy. The famous message, "Scratch one flattop!" from a Navy pilot to his carrier in the Coral Sea, was a message for which many others had helped to pave the way. And at the decisive battle of Midway, where we turned back the Jap threat to Hawaii, it was by radio telephone that Admiral Spruance summoned planes from all quarters to pour it on the Jap fleet.

In land warfare, where battles are planned and fought at closer quarters, wire lines are still the basic and indispensable means of communication. The nearer the battle line, the more necessary the wire. "For secret, heart-to-heart military confabs," said a newspaper report from General Bradley's headquarters in France, "wire, exchange operators, and the human voice still must be relied upon. General Bradley has a group of the best telephone construction engineers in the world to keep his telephone communication going whenever he moves ahead to maintain contact with his advancing forces. . . . The faster the corps moves forward, the faster their telephone lines must be lengthened, and when the troops are slashing forward swiftly the wires have to keep up with them also."

DO YOU remember the time when General Eisenhower jokingly asked General Patton, "Why don't you get the lead out of your feet?" One of the remarkable things about this question was that General Eisenhower was able to voice it *over the telephone* to a tank commander moving ahead as fast as his tanks could roll.

During the first 22 days of the invasion of Italy, American Signal

Corps units laid more than 5,300 miles of assault wire, field wire, and cable. I could give many other facts illustrating the essential part played by the telephone—in observing and correcting artillery fire, for example—but I am sure you fully understand and appreciate it. To all of us here the subject is especially important. Many of the men responsible for the success of combat communications are members of our telephone family who were ready and equipped with telephone "know how" when the call came to them. Our industry is supplying huge amounts of the equipment used. And finally, it is we who at all times, in peace as well as in war, have the responsibility for developing and bringing to the highest possible level an art which is so vital to the nation in time of crisis.

The contributions of the research and manufacturing branches of the telephone industry to the successful prosecution of the war have by no means been limited to communications. The development of special radar and other electronic equipment and its manufacture have been outstanding achievements. In fact, the industry has been the largest producer of electronic equipment in the United States, besides being the largest producer of war communication equipment.

Meanwhile, as we plug hard at our job, more than 70,000 members of the telephone team have joined the armed forces. That is not part of our contribution to the war; it is their own contribution. But from them we draw our deepest inspiration; what they are doing intensifies our resolve to do everything we possibly can to help them get home quickly. We look forward with eagerness to the time when we can welcome them back as active members of the telephone family—and that time cannot come too soon.

In speaking as I have of the telephone industry's war record, and its ability to overcome great difficulties, I have had two thoughts in mind. One, as I have already indicated, is simply that while there are most assuredly a lot of hard jobs ahead of us—some of them perhaps harder than any we have yet faced—we have learned much that is of permanent value and we ought to be able to tackle the future with confidence.

The other thought is that the overall war job of our industry is only the sum of hundreds of thousands of jobs that telephone men and women have so ably performed as individuals. In all branches of all organizations in the industry, the people who *are* the industry have dedicated their spirit of service, as well as their skills of head and hand, to the great task that is theirs. This spirit will, I am sure, be the priceless asset of the future, as it is of the present.

Public Telephones for Returning Servicemen in Army and Navy Hospitals Are Appreciated as a Convenience by the Men and as a Morale Builder by Medical Officers

"I Knew Then I Was Home"

Burton A. Hollingsworth

Down the long corridor of an Army hospital located near the east coast of this country marches a column of soldiers. Their steps are slow and their boyish faces are tired and worn. They have just disembarked from a hospital train. They know that after a few minutes in the hospital's receiving room they will at last be at liberty to rest. They have been on the move ten days since they left a base hospital in Europe—ten days in motor transports, ships, trains and ambulances.

As they pass the PX, one of them cries out, "Gee—malted milk and ice cream!" A moment later another exclaims, "Boy, look—telephones!" Two drop their baggage, break ranks, and make for the attended telephone center. The officer in charge, realizing that this is the first opportunity these men have had in nearly two years to talk with loved ones, disregards the irregularity and permits the whole group to "fall out." They swarm into the center. It buzzes with activity.

Excited, anxious faces crowd around the counter and ask the telephone attendant for numbers in Pittsburgh, Kokomo, Waycross, San Francisco, Castine. Excited, anxious voices fairly shout to parents and wives who have waited months to hear, "It's me, it's Bill, I'm back!" One sees a variety of emotions as they place their calls. Some joke and chide one another, others are more serious, some nervously bite their lips, others ask questions in short, jerky spurts: "Could I call next door and ask them to get my father?" "You're sure the operator can get our new phone number?" "How long will it take to get Birmingham?" Several times the attendants have to start conversations for men too emotionally upset to talk when members of their families answer the calls. Or they console boys who hear for the first time of tragedies which have occurred during their absence.

This is an actual occurrence, but it is only one of hundreds. Scenes like it are being enacted in Army and Navy Hospitals all over the country whenever such groups of men first arrive back in the United States.

Men, wounded in mind and body, are being returned to establishments far from the battle fronts for convalescence under the finest medical and rehabilitation facilities in the world. Many are brought back by ship; some are flown directly from field shelters behind the lines, arriving only a few days following their injuries; some have already been in overseas hospitals for weeks.

THANKS to modern therapy, most of the men suffering from even the severest wounds will be rehabilitated and enabled to lead lives of normal activity. But the most modern medical and psychiatric care, the finest surgery and appliances, expert rehabilitation, vocational training, and employment opportunities are far from being all that is needed by men who have suffered disfigurements and disabilities. If a young man returns from combat with a disfigurement or other serious disability—whether deafness, blindness, a shattered body, an amputation, or burns—he is almost certain to be emotionally disturbed. The most serious wound he brings back may be mental. It is only natural that maimed young men should think bitter thoughts, lose their self-confidence.

And yet, in case after case these men have been freed from their black thoughts and bitterness and have had their self-confidence restored by the expert rehabilitation treatment they have received, as soon as possible after injury, in Army and Navy hospitals. In all of these establishments, the restoration of self-confidence as an aid in the restoration of physical health is the immediate aim of doctors, nurses, and other personnel.

Almost without exception, the boys upon their return to this country ask first for favorite foods which they have missed, such as malted milk, fried chicken, and watermelon; and for the opportunity to talk with their families at home.

Medical officers in both the Army and Navy feel that the improved mental attitude which is noticeable in patients after they have called their families is an important factor in the treatment of these men. The commanding officer of one large Army general hospital, in writing to the telephone company, said: ". . . one must see our patients when they arrive, then observe them after they have completed their call to the folks back home, to realize what prompt and efficient telephone service means to men who have been overseas from a year and a half to two years. From the standpoint of morale of the fathers, mothers, and soldiers I can think of no finer service. . . ."

Appropriate Arrangements

MANY FACTORS have a bearing on the particular telephone arrangements which are most appropriate for a given establishment and the men who are hospitalized there. Among them are such matters as the degree and kind of the men's disabilities, the location and layout of the hospital, where the majority of the men's homes are situated, and the telephone requirements of personnel other than patients. In the larger Army and Navy hospitals throughout the country, the provision of attended service in telephone centers and of bedside service for men who are confined to bed, under the general supervision of

a telephone man assigned as "telephone manager," meets adequately and conveniently the telephone needs of hospitalized men.

The attended telephone centers, so situated as to be accessible to all ambulatory patients, even those on crutches and in wheel chairs, have become popular meeting places. Behind the counters in these centers are telephone company attendants to take the calls and put them through as fast as crowded circuits will allow. The selection and training of women for this type of work is of utmost importance. Dealing with men with physical handicaps, often with nervous manifestations, requires an unusual amount of patience, judgment, and sympathetic understanding.

Telephone attendants play a daily part in the rehabilitation program. They are not only called upon to render many unusual services to patients, but are also faced with the important task of dealing with them in such manner that they will not incite self-pity nor in any way hamper from a psychological standpoint the rehabilitation which is being carried on by Army and Navy authorities.

Even though a disabled soldier or sailor be surrounded with sympathy, waited on hand and foot and given countless attentions, he may still despair. He may still view himself as

Comfortable furnishings, and magazines, stationery, and a cordial greeting and friendly atmosphere make waiting for their calls at attended locations no hardship for patients in Army and Navy hospitals

a martyr—an attitude which brings little happiness to him or to anybody else. If his faith in his ability to do things is restored, the rest of the treatment is easier. The telephone representatives in a hospital find many opportunities to contribute to restoring patients' self-confidence.

A YOUNG BOY whose wounds had necessitated the amputation of both legs was so conscious of his handicap that he refused to leave the ward. Although physically able to do so in a wheel chair, he flatly refused to attend entertainments, go to the mess hall, or avail himself of any of the recreational facilities which were available. Finally, after much persuasion, a Red Cross worker got him to go to the Red Cross recreational building. While there, he noticed the attended telephone center which is adjacent to it. He ventured up to the door and peered timidly in. One of the attendants saw him and called, "Come on in, soldier," but he turned his chair and went away without answering.

Within a half-hour the attendant again noticed the same boy looking in, so she went to him and asked if he wouldn't like to call home. She pointed out that in the center there was a booth large enough so that he could roll his chair inside, close the door, and have all the privacy he desired. She said, "Just tell me where you want to call, go in the booth, and I'll do the rest." The desire to call home won out, and he went into the booth and was soon talking with his parents. From then on, he was a different boy. He started going about, found new friends all over the hospital, became interested in a hobby, and made frequent calls home—all of which contributed substantially to improving his condition.

Special facilities have been devised for the comfort and convenience of patients, and often use of them results in unusual and interesting experiences. For example, let's take Tony. Tony came back with both arms off just below the shoulder, and had recently been fitted with artificial arms. He found his way to the telephone center one day and an attendant, realizing that Tony would have difficulty in using a regular telephone, mentioned that there was a head set and chest transmitter in the center and that she would be glad to adjust this equipment so that he could place his call and talk without the necessity of holding a telephone.

Tony, however, was looking to the future. He said, "You know, when I get out of this hospital I'm going to have to learn how to do lots of things for myself, and I think one of them will be to use a telephone. If you will hold a telephone for me for just a minute, until I get the feel of the thing, I might just as well start learning now." After a few minutes of experimenting, both in picking up and in holding the telephone, Tony said, "O.K. Get me Morgantown, West Virginia, please, and watch me go to town." Tony talked for ten minutes on that call, and his new-found pleasure resulted in his becoming a regular patron.

A Link with Home

THE telephone centers are comfortable, friendly, cheerful places and seem to help the man to relax. The out-of-town telephone directory rack is the scene of much activity. It's not

uncommon to see a newly arrived man dash for the rack and hurriedly leaf through the pages of some directory. Perhaps there isn't even a telephone at his home, but it's mighty good to locate the names and addresses of neighbors and friends. Telephone directories placed on a low shelf, so that wheel chair patients needn't ask help in consulting them, are helpful in teaching the men self-reliance.

Hospital authorities prefer that men do as many things for themselves as possible, as it helps them to rebuild their strength and self-confidence. The over-sized telephone booths have been designed with this in mind; and these and doors which may be opened and closed by pull cords by the patients themselves meet with the hearty approval of both authorities and patients. The large booths are usually equipped with seats which swing out of the way, head sets and chest transmitters, regular telephone sets, and amplifying equipment for use by men with impaired hearing. Many of them are large enough to accomodate a man on a litter. Thus the special equipment is available for use by any patient, regardless of his injury.

Booths without seats are provided for men whose crutches or casts make sitting impossible or, at best,

Specially constructed booths, large enough to admit patients in wheelchairs or on litters, and with doors designed so that patients may open and close them without assistance, are a much appreciated feature in hospitals

difficult. Hooks are installed in these booths upon which men may hang their crutches.

Convalescing men seldom feel like standing in line or leaning against a wall when delays in their calls necessitate waiting. To make the telephone centers more homelike, comfortable furniture, and such things as magazines, newspapers, and stationery, are furnished so that men while waiting may read, smoke, write letters, and lounge at ease. Booklets describing and picturing the hospital are of special interest to the patients and many of them are mailed home as souvenirs. At holiday times, the room is appropriately decorated and the attendants help the men get into the spirit of the occasion by serving candy, nuts, pop corn, soft drinks, or whatever refreshments may be timely for the occasion.

The attendants all take personal interest in seeing that the men's calls get through. One girl actually talked a garage man in a small town into rowing three miles across a river to bring back the mother of a boy who wanted to talk to her. Police stations, sheriffs' offices, ration boards, town post offices—all of these have been asked to help in tracing folks who have moved or have had their telephones disconnected.

All one boy knew was that his wife had moved in with another girl in an apartment house and that he wanted to talk with her. As it was not a large town, the attendant checked with the local operator and found that there were three apartment houses in the town; so she called each one of them. The superintendent in the third house inquired, "Is she the woman with twins?" She was, and within a few minutes the year-old twins and Mother were all trying to talk at the same time.

Perhaps the patients who get the greatest lift from the use of a telephone are those who are confined to bed. These boys, due to the nature of their injuries, are unable to enjoy most of the recreational facilities provided in the hospital; and many a patient shows marked mental and even physical improvement when arrangements are made for him to place a telephone call to his family while still flat on his back.

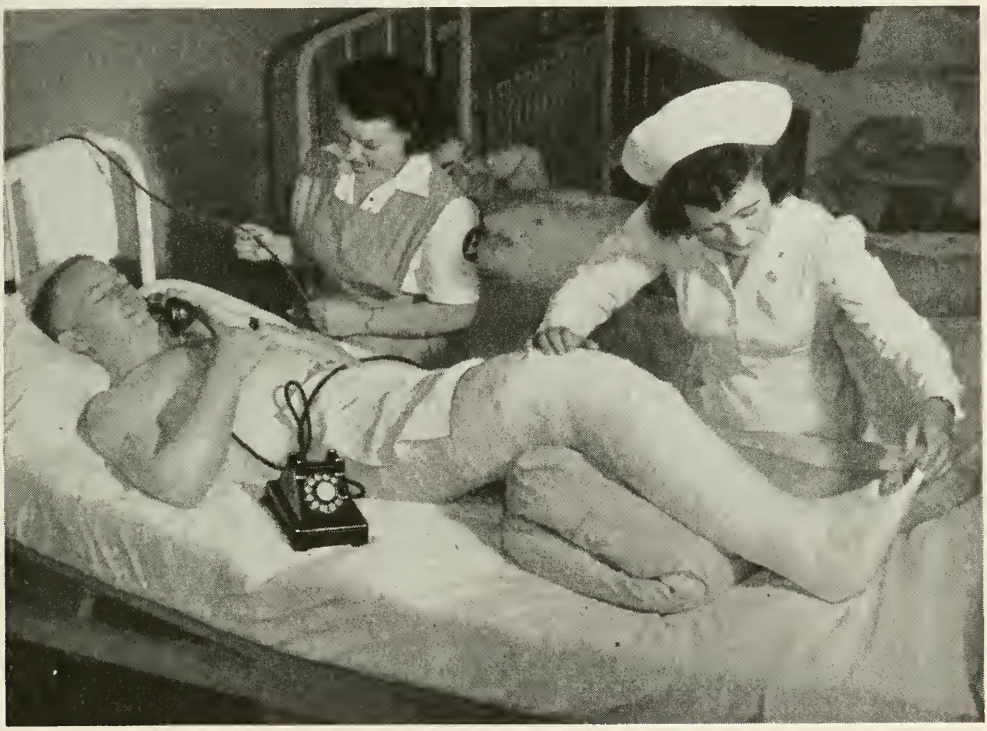
Providing Bedside Service

BEDSIDE SERVICE is provided over extensions from the attended center, which terminate in jacks suitably placed in the wards. Nurses or telephone company attendants, usually girls wearing uniforms or some other means of identification, deliver portable telephones, which plug into a near-by jack, to the bed patients when they want to place calls. On their trips through the wards, the attendants look up telephone numbers, assist in filing the calls, explain the classifications of long distance service, and furnish rate information.

In one ward, the men were being entertained on one occasion by a pianist and a girl singing popular songs. It happened that one of the boys who had both arms in casts knew that the only time he could reach his wife was during the time the program was in progress. When the telephone was brought to his bedside by the attendant and the call was established, other patients saw the attendant hold the telephone instrument for him with one hand and hold one

finger of her other hand in his ear to block out the room noise.

Another patient, whose leg was very seriously injured, was considered by the doctors to be in such a condition that recovery was unlikely. He showed little interest one way or the other. When jacks were installed in his ward and the selection of the first man to make a call from bed was being considered, the surgeon in charge suggested that he be chosen, in the hope that talking with his wife might change his mental outlook sufficiently to influence his physical recovery. Because of the seriousness of his condition, his wife was called and informed in advance of the conditions under which her husband would make the call. After this first telephone visit with his wife, the patient's condition improved so much that he was soon out of danger. Ward bedside service means much to him now, as evidenced by his one or two calls each week to his home.



Nurses or telephone company attendants, the latter usually wearing uniforms or some other means of identification, deliver portable telephones to bed patients, and help them with the details of or information about their calls if they should need assistance

Men who are flown directly from the European battle fronts to hospitals in this country often arrive as soon as the fifth day after they are injured, and sometimes their families have not yet been notified of their

wounds. Naturally, it is one of the first desires of these men to call home, and hospital authorities feel that bedside telephone service is one of the essential features in the operation of such a receiving hospital.

Usually these men are much more worried about how their mothers, wives, or sweethearts will take the news of their injury than they are about their own condition. "How will I tell Mary I've lost a foot?" is a familiar question to the hospital telephone attendant. "Should I hold her to our engagement, made a year ago?"

One young flier who had lost a leg was very hesitant to tell his wife about his loss because he was uncertain what her reaction might be when she learned that he would be permanently crippled. He finally decided to call her and tell her of his arrival, and arranged for her to visit him at the hospital as soon as she could do so. She arrived a few days later, and when the patient was assured that his wife, overjoyed at his return, was more than willing to help him overcome the handicap, his mind was so relieved that he responded much more favorably to treatment by the medical authorities.

Telephone Managers

TELEPHONE MANAGERS have been assigned to the larger hospitals to keep abreast of the requirements of the men and to provide a direct day-to-day contact between the telephone companies and the hospital authorities. The managers function along the lines of the camp managers in military and naval camps and bases.* They make sure that the most convenient telephone arrangements are provided at the right places, in the right amounts, and of the right kind. As men improve and gain strength enough to be out of bed part of the time, or as they are released and new groups arrive, the requirements for different types of telephone equipment may change, and the telephone manager is on the job to see that the necessary changes are made promptly.

Telephone managers spend a great deal of their time talking with the patients as they gather in the attended center, and in visiting with the men who are confined to their beds. Their friendly, helpful attitude often enables them to help patients with mental and physical handicaps get things straightened out so that the world looks brighter to them.

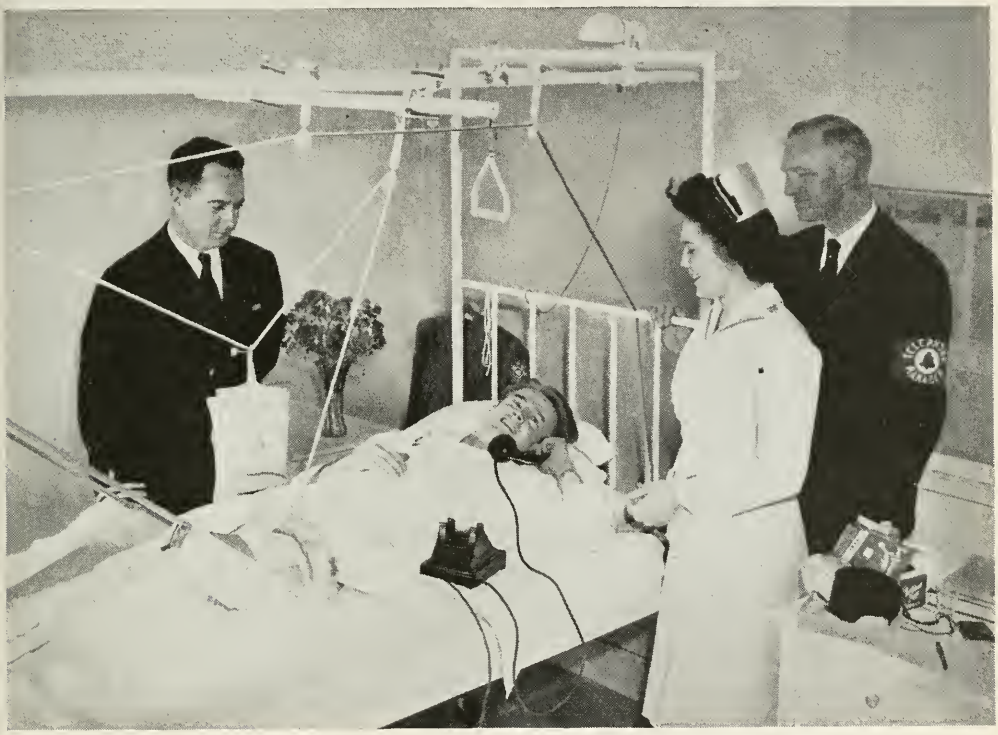
For instance, the big 220-lb. 19-year-old, whose legs had been badly shot up, had given up entirely. In spite of many operations, his improvement was so slow that he didn't much care whether he got well or not. He was morose, refused to coöperate with doctors or nurses, and ignored other patients. The telephone manager put this boy on his daily schedule for a visit.

It was a month or so before the patient warmed up to these visits, but gradually he came to look forward to them, and a friendship grew between the two which enabled the manager to learn much of the boy's background. It developed that he hadn't called or written to his mother. The manager finally, after much persuasion, prevailed upon him to call her. According to the hospital authorities, that call was the turning point. The boy soon arranged for

* See "Service for Service Men," MAGAZINE, February, 1943.

his mother to come and visit him, and from then on he showed marked improvement and, as the manager said, "He became my assistant manager."

The telephone companies offer deferred payment arrangements whereby the men can go ahead with their calls and, if they wish, pay for them later at their convenience. This feature of the service is made known to the patients by means of notices and pamphlets which are given them upon their arrival and posters displayed throughout the hospitals. Of course, many patients place their calls "collect," so that charges are billed to the called telephone. Also, in many of the hospitals, newspapers, employee groups, businessmen's clubs, or similar organizations have sponsored funds which are used to pay for one call anywhere in the United States for each service man returned from active combat duty.



TELEPHONE MANAGERS spend much of their time talking with patients at the attended center and visiting those who are confined to bed. Their helpfulness not only in the matter of telephone calls but with an occasional personal problem often contributes greatly toward recovery

Meeting the urgent and special telephone requirements of men returned to this country for hospitalization by arranging telephone equipment so that it is convenient and

pleasant for them to use, regardless of their physical condition, has been looked upon by the telephone companies as one of the most important jobs they have tackled during the war—and one of the most satisfying in its accomplishment.

Most of the operating companies of the Bell System have in their territories one or more Army or Navy hospitals, and are providing in general the kinds of service here described for the men hospitalized in them. That these services are sincerely appreciated by the men is attested by their use of them. That they are so much used, and that they prove both pleasing and convenient, comes about because each of the companies has not only adopted a comprehensive program for service at such hospitals but has studied carefully the layout of the individual institution and the probable needs of the patients in it. Members of the A. T. & T. Company's O. & E. Department have helped too, visiting many of the hospitals and the companies and providing for an interchange of experience and ideas.

The value placed upon this service in hospitals by the military authorities was recently expressed by the Commanding General of the Fourth Service Command, on the occasion of the presentation of the National Security Award to one of the telephone companies. The General said, "One of the Army's greatest obligations today is to our returned wounded personnel, to remake their health and to sustain their spirits, so that we may return them to their communities as good citizens after the war and, so long as it is necessary, return some of them to the battle fronts as good soldiers. In this caring for our wounded, morale is unquestionably of paramount importance. And in the building of morale, the special new telephone equipment which you have installed in many of our hospitals is of immeasurable value. It is appreciated, believe me, by the men, and by the Army."

As to the appreciation felt by the service men themselves, one need only to consider the remark of a young army private recently returned from Sicily who, in answer to a question by the hospital's "Inquiring Photographer," said, "What gave me my biggest thrill when I returned to the States? Out of a hundred things I could think of—American automobiles, American trains, American girls, only one thing thrilled me most. . . . The moment when a telephone operator at the hospital attended location contacted a warm, human, loving voice that said, 'Hello, Son. It's good to hear your voice.' A thrill? It's an understatement. I knew then I was home."

Bravery, Devotion to Duty, Self Sacrifice Are Qualities Exemplified by Telephone Men in the Armed Forces Which Have Been Recognized by a Variety of Awards

For Heroism, Gallantry, or Extraordinary Achievement

Donald S. Bridgman

On January 12, 1943, First Lieutenant Weldon S. Sims, former combinationman of the Southern Bell Telephone and Telegraph Company, was killed in action on Guadalcanal Island.

"While his company was pinned to the ground by heavy machine gun fire, Lieutenant Sims volunteered to advance ahead of the lines to secure information concerning the terrain and objectives of the intended advance. Carrying with him communication equipment which rendered effective concealment impossible, he advanced across rugged terrain, swept by rifle, machine gun, and mortar fire, sending back to the battalion commander valuable information which enabled the placement of effective mortar fire upon vital areas. Lieutenant Sims was finally sighted by the enemy and met death from short range machine gun fire. Because of his voluntary action, the troops were inspired to attack and the information he secured greatly facilitated their advance."

This quotation is taken from the citation accompanying the posthumous award of the Distinguished Service Cross "for extraordinary heroism" to Lieutenant Sims by Lieutenant General Millard F. Harmon, commander of the U. S. Army Forces in the South Pacific Area. The Distinguished Service Cross is the highest honor received by a Bell System man in this war, so far as is known, and it has been given to only three other Bell System men in the armed service of their country.

His deed exemplifies the timeless qualities of courage, devotion to duty, and self-sacrifice for one's comrades and one's homeland revealed in men by great crises throughout history. For telephone men and women, it illustrates also the essential value of modern communications in this World War and how their effective use by one valiant man can help to save the lives of many others.

Weldon Sims is one of a shining

LIEUT. WELDON S. SIMS
Distinguished Service Cross (posthumous)
Killed in action

company of Bell System employees now on military leave of absence to whom decorations have been given for outstanding deeds and achievements in the nation's military and naval service as symbols of its gratitude and recognition of unusual bravery and fidelity to duty. Those receiving them prize these decorations as evidence of success in meeting a special challenge but would be the first to claim that their honors are also honors to comrades who, under similar circumstances, would show like daring and determination.

No record of the accomplishments leading to these awards can portray the hardships and suffering incurred. No article of this kind can mention more than a few typical cases for which the different kinds of decorations were given. Frequently, word of an award has come through a story picked up from a local newspaper and, although the System companies make every effort to learn of achievements of their men in service, it is certain that some, perhaps many, decorations have been earned which have not been reported or about which the information is very scanty. In some instances, the Army and Navy have been asked for official citations, and the quotations throughout the article are taken from them. It has been a thrilling assignment to read the accounts which have been secured, and it is hoped that this article can provide for the MAGAZINE's readers some conception of the magnificent things their fellows are doing in all parts of the world.

The types of achievement for

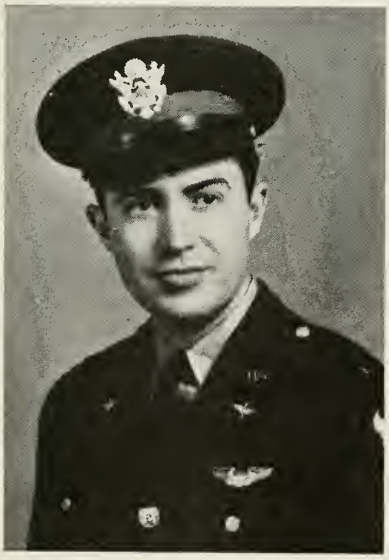
LIEUT. LUTHER G. BREWER
Distinguished Service Cross (posthumous)
Killed in action

which the principal decorations of the armed services are awarded are summarized below in the established order of precedence. Except as noted, they are given by all the services. In time of war, while the Coast Guard serves with the Navy, its members are eligible for Navy decorations.

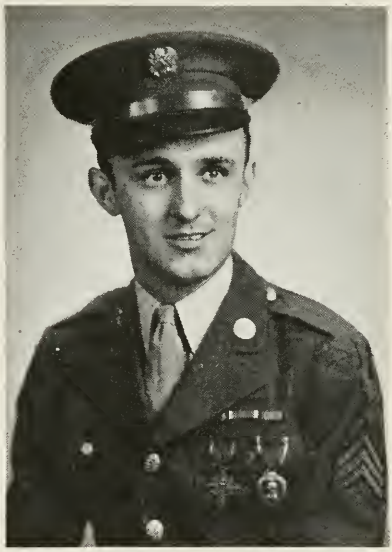
Medal of Honor (Army)—For gallantry and intrepidity at the risk of life above and beyond the call of duty. Although a different decoration, the Navy Medal of Honor is also its highest award and is given for similar actions.

Distinguished Service Cross (Army)—For extraordinary heroism in military operations against an armed enemy. The corresponding Navy decoration is the *Navy Cross.*

Distinguished Service Medal—For exceptionally meritorious service in a post of great responsibility.



Capt. Lewis N. Ellis
Distinguished Service Cross, Air Medal with three Oak Leaf Clusters, Distinguished Flying Cross
On active duty



Sgt. Arthur J. O'Keefe
Distinguished Service Cross
Wounded in action, recovered, honorably discharged, and re-employed by the Wisconsin Telephone Co.

Legion of Merit—For exceptionally meritorious conduct in the performance of outstanding services.

Silver Star—For gallantry in action.

Distinguished Flying Cross—For heroism or extraordinary achievement in aerial flight.

Soldier's Medal (Army)—For heroism not involving actual conflict with an enemy. The *Navy and Marine Corps Medal* is the corresponding decoration in those services.

Bronze Star Medal—For heroic or meritorious service against an enemy not involving aerial flight.

Air Medal—For meritorious achievement in aerial flight.

Purple Heart—For wounds received in action against an enemy.

Members of the Marine Corps may also receive the Brevet Medal awarded for distinguished service in the presence of an enemy and ranked just after the Medal of Honor. No decorations are issued more

than once to any individual. In the Army, Oak Leaf Clusters are added to the original decoration for each succeeding deed meriting such an award. In the Navy, stars are given under similar conditions.

A FEW months after Weldon Sims gave his life in the steaming jungles of Guadalcanal, another Southern Bell man, a junior clerk in the accounting department, earned a D.S.C. at the cost of his life "for extraordinary heroism" in the cold and fog of Attu in the Aleutians. On May 26, 1943, Second Lieutenant Luther G. Brewer's platoon

Distinguished Service Cross — Legion of Merit

"was stopped as it advanced up a precipitous ridge north of Chichagof Valley by a strong enemy machine gun and rifle position. The advantageous location and fortification of the enemy made it imperative that they be reduced before our troops in that sector could move forward. The platoon sergeant and two men were killed as they attempted to knock out the enemy position. In the face of almost certain death Lieutenant Brewer courageously dashed forward alone under withering enemy machine gun and rifle fire to a point within grenade range of the enemy position. Although mortally wounded by enemy fire, Lieutenant Brewer successfully grenaded the enemy until they were destroyed. By his daring and fearless action and the inspiration of his gallantry, Lieutenant Brewer's platoon and other troops moved forward to accomplish their missions."

THE THIRD D.S.C. won by a Bell System man was awarded to First Lieutenant Lewis N. Ellis, also from the Southern Bell, who had been an office manager in the commercial department, "for distinguished service, extraordinary heroism, and gallantry in action" on the initial raid against the Ploesti Oil Refineries in Roumania August 1, 1943.

"On the approach to this strategically vital enemy target, Lieutenant Ellis, pilot of a heavy bombardment aircraft, flew his plane in at an altitude of 200 feet, through a concentrated and deadly curtain of anti-aircraft fire which increased in intensity as he came nearer the objective. At the target itself, Lieutenant Ellis, displaying cool and courageous flying skill, flew his ship directly through columns of smoke and fire in order to drop his bombs on the designated pinpoint. So heavy and accurate was the enemy flak that the left elevator control was shot off, the left elevator itself riddled with bullets, the hydraulic and oxygen systems thrown out of commission, the nose wheel mechanism destroyed, and one of the engines disabled. On leaving the target area after successfully bombing the selected objectives, Lieutenant Ellis' bomber continued to be under fire from enemy ground installations and, furthermore, was subjected to attacks by many enemy pursuits. During a 45-minute running battle, four of his crew members were wounded, and the tail and top turrets were shot out of commission, yet Lieutenant Ellis, by a display of masterly piloting, enabled his gunners

to shoot down one and probably two of the attackers. His skillful and valorous performance of duty, when faced with extreme peril, constitutes heroism and devotion to duty of the rarest kind."

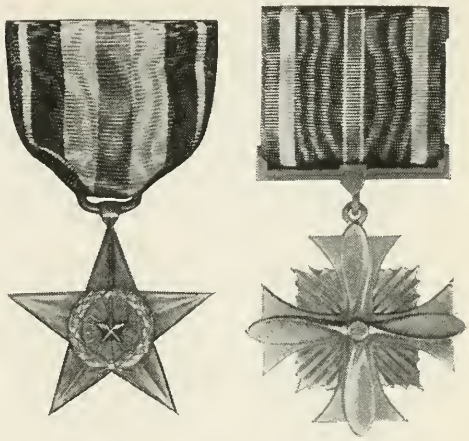
More recently, Ellis, now a Captain, has been awarded the Air Medal, three Oak Leaf Clusters, and the Distinguished Flying Cross for extraordinary achievement as a bomber pilot on flights over continental Europe.

THREE DAYS LATER, under the shadow of Mt. Etna in Sicily, the fourth Bell System man earned his D.S.C. This was Sergeant Arthur J. O'Keefe of the Wisconsin Telephone Company's plant department, who as

"leader of a rifle squad, led a bayonet charge on the company's objective. Although seriously wounded four times, he pressed the attack, his squad being the first to occupy the objective. While waiting to be evacuated, he directed his squad in a successful repulsion of an enemy counter-attack. During this latter action, he was wounded again several times. The extraordinary heroism, determination, perseverance, and aggressive leadership displayed by Sergeant O'Keefe reflect the finest traditions of the Armed Forces and are deserving of the highest praise."

O'Keefe's decoration, for which he was recommended by Lieutenant General George S. Patton, was actually received at a military hospital in this country, to which he was transferred from a hospital in North Africa. After spending eight months recovering from his wounds, he was discharged from the Army and was reëmployed by the Wisconsin company in the plant department.

AWARDS of the Legion of Merit have been reported for twenty-two System employees in the Army and two in the Navy and Marine Corps. Given for "exceptionally meritorious conduct in the performance of outstanding services," these awards generally recognize outstanding performance in the accomplishment of a difficult task requiring weeks or months to complete. Since, for telephone men, exacting assignments frequently have involved the establishment and maintenance of communications, the



Silver Star — Distinguished Flying Cross

majority, but by no means all, of these awards have been for achievements in that field.

Such an achievement under the toughest sort of conditions was that of Corporal Belton K. Vaughan of the Western Electric Company's sales department, who won his Legion of Merit

"while serving with the wire section of a Marine Aircraft Group in the Solomon Islands Area from November 2, 1942, to April 1, 1943. Employed in the construction and maintenance of telephonic commu-

nications for all aviation units on Guadalcanal, Corporal Vaughan, despite Japanese naval bombardment, artillery fire, and bombing raids, repaired with efficient promptness all operational circuits necessary to the effective control of aerial combat and the sound power circuit upon which the whole island command was dependent for air raid warnings. His skillful workmanship and fearless devotion to duty contributed materially to the successful operations of our forces against the enemy during a critical period when the island was under heavy siege. Corporal Vaughan's gallant

Soldier's Medal

Navy and Marine Corps Medal

conduct was in keeping with the highest traditions of the United States Naval Service."

In a very different field is the achievement of Lieutenant Commander George M. Ankers, U. S. Naval Reserve, Office of Salvage, Bureau of Ships, a lineman in the Pacific Telephone and Telegraph Company, who has become one of the Navy's outstanding salvage experts. After directing the raising of the first sunken battleship to be floated at Pearl Harbor, he landed in North Africa with a commando group and helped to clear the harbor of Oran of obstructions placed by the enemy there. His Legion of Merit was awarded—and special commendation from General Eisenhower was given —for his work as

"Salvage Officer at Bizerte, Tunisia, during the month of May, 1943. Charged with the difficult task of opening the channel to Lake Bizerte which the retreating enemy had blocked with wrecked ships, Lieutenant Commander Ankers immediately initiated plans for blasting an opening through the obstructions. Although subjected to persistent enemy air raids during the operations, he persevered in the face of constant danger and achieved success to the extent that in record time the Port of Bizerte was almost fully utilized. Lieutenant Commander Ankers' extraordinary ability and courage in the timely completion of an important task contributed immeasurably to the uninterrupted supply of allied armies for future operations in Sicily and Italy."

In one of the first of those operations, Major Rand S. Bailey of the Corps of Engineers, an engineer in the A. T. & T. Company's Operation and Engineering Department, performed outstanding services leading to a Legion of Merit award.

"During the planning, training, and operational phases of the Seventh Army landing operations on the southern coast of Sicily, Major Bailey was responsible for signal communications of the 1st Engineer Special Brigade and attached units. By the application of highly superior technical knowledge, by masterful control and coördination of the various signal teams in the Brigade communications net, and by extraordinary attention to duty, Major Bailey maintained highly superior radio, telephone, and courier communications with tactical Brigade and attached Units, and with cooperating naval units. He exercised outstanding initiative in discovering and em-

ploying serviceable captured enemy signal equipment. His untiring devotion to duty and his superior management and coördination of Brigade communications have been an inspiration to this command."

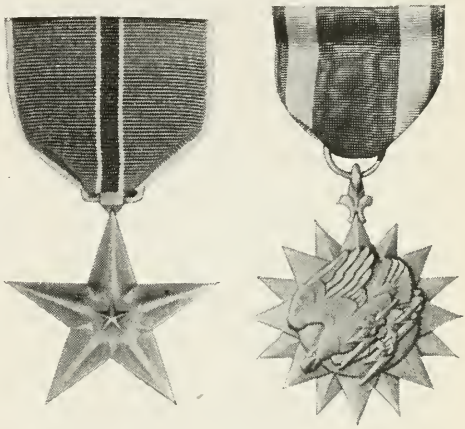
Bailey, who has more than thirty-five years' service with the New England Telephone and Telegraph Company, Bell Telephone Laboratories, and the American company, recently has been made a Lieutenant Colonel and has been awarded the Bronze Star Medal for his outstanding work in establishing communications for an Engineer Corps unit in Normandy on D–Day.

As the rapid-fire Sicilian campaign developed, two other Bell System men won the Legion of Merit through outstanding communications work. One of these awards, based on accomplishments both in North Africa and Sicily from November 8, 1942, to August 25, 1943, was given to Master Sergeant Orman H. McConville of a Light Construction Signal Aviation Battalion, a groundman from the New York Telephone Co.

"By his unswerving devotion to duty, cheerful coöperation, good judgment and initiative in the construction and maintenance of lines of communication, he has increased the efficiency of the battalion. During the North African and Sicilian campaigns he played a major part in the repair and maintenance of lines of communication by working day and night without sleep, many times without food, and under artillery fire, mortar fire, and enemy strafing. Sergeant McConville has rendered many valuable suggestions to his superiors pertaining to line construction and maintenance and by his skill and ingenuity many problems have been solved, enabling the battalion to function more rapidly and efficiently."

The award to the other man, Lieutenant Walter G. James of the Signal Corps, a lineman from the Pacific company, was based on his work in Sicily alone between July 12 and August 18, 1943.

"Lieutenant James was charged with the seemingly impossible task of installing and maintaining wire communications between a corps headquarters and rapidly advancing divisions during the Sicilian campaign. With dogged determination and outstanding initiative he led his men through unswept mine areas, often in the face of hostile artillery fire, and on several occasions in advance of the leading infantry elements. His lines were frequently destroyed by enemy action, but his conduct under adverse conditions, his leadership and high degree of technical skill inspired the men under his command to perform far beyond their normal capabilities, with the result that the vital mission was successfully accomplished."



Bronze Star Medal — Air Medal

One of the latest Legion of Merit awards reported has been that won by William R. Silvey, of the New York company's engineering department, recently promoted from Lieutenant Colonel to Colonel in the Army's General Staff Corps. Col.

Silvey is a veteran of World War I and was awarded the Silver Star for "bravery of the highest order" in that conflict. His present award is for outstanding services from October 20, 1943, to May 31, 1944, in connection with the advance planning of invasion operations,

"performed so tirelessly and efficiently that necessary information was in the hands of proper units well in advance of schedule."

THE SILVER STAR for gallantry in action has been won by thirty-one employees of System companies in the Army and by three in the Navy. One of these men, First Lieutenant Carl E. Anderson, an engineer from the Southern New England Telephone Company, also was awarded a Croix de Guerre with Gold Star by the French Government for the same achievement early in the Tunisian Campaign. A field artillery officer, responsible for his battery's observation posts, he helped to provide the advancing infantry elements with the best artillery support. In the language of the French citation,

"an officer of courage and coolness, worthy of praise. In the course of the Ousseltia engagement from 25 to 28, January 1943, he chose to accompany up to the enemy lines an infantry patrol. In spite of the heavy automatic enemy fire he succeeded in obtaining valuable information."

A few weeks later, during the critical retreat near Kasserine Pass before Marshal Rommel's furious counterattack, the Silver Star was won by Private (now Technical Sergeant) Benton Lynch, of the Signal Corps, a cable splicer's helper from the Indiana Bell Telephone Company.

"On February 18, 1943, he was subject to hostile artillery fire, hostile aircraft, and approaching enemy tanks. Private Lynch was with a crew of six men that remained forward of our own front-line units in order to destroy existing pole line and wire facilities to prevent the use of the wire communication installations by the enemy. He executed his mission with complete disregard for his own personal safety although he was fully aware of the approaching enemy tank attack. The courage, heroism, and the unceasing devotion to duty displayed reflects great credit upon himself and the armed forces of the United States."

Silver Star awards to two other Bell System men for achievements in the same campaign are notable illustrations of the responsibility of the infantry for communications in combat areas. Members of the first infantry division, these two men, Russell K. Heller of the Ohio Bell Telephone Company's plant department, and Charles W. Hoertel, Western Electric installation department, were decorated for successfully repairing severed communications lines in exposed positions while subject to intense enemy fire.

Uninjured in that engagement, Hoertel was wounded at Mateur, captured by the Germans, bombed day and night by allied air forces while on a prison ship, rescued when Tunisia fell, and wounded again in Sicily. He is now recovered, and is a sergeant instructor in a Signal Corps school in an inactive area in Italy.

The Salerno beachhead in Italy will long be remembered for the powerful and desperate German resistance there. Another Bell System infantryman and winner of the Silver Star, Lieutenant Colonel Edward N. Harris, Jr., Long Lines testboardman from Texas,

"division liaison officer with an infantry

battalion, landed in the assault wave at Salerno Sept. 9, 1943, in the face of withering artillery, machine gun and mortar fire from organized and fortified enemy positions. Throughout the intense battle and despite repeated tank attacks and severe enemy fire, Colonel Harris moved among the most forward troops assisting in the attack. On one occasion, while well in advance of the attacking riflemen, he killed an enemy soldier with pistol fire. His calm leadership and cool determination inspired the attackers to increase their efforts to continue the battle to its ultimate success. His gallant action reflects great credit upon himself and the Armed Forces of the United States."

Meanwhile, far to the East, our forces were working their way toward Japan through the island outposts of the South Pacific. On July 20, 1943, at Bairoko Harbor, New Georgia, in the Solomons, Private First Class Elzie J. Hancock of the First Marine Raider Regiment, a cable repairman from the Southern Bell, in the face of intense fire, three times guided his company into position for assaults against a Japanese machine gun emplacement. When his entire battalion was threatened by devastating flanking fire, Hancock exposed himself with no concern for his own safety, to keep the right and left flanks of his company in contact with each other. Finally, leading a charge which silenced the enemy guns, he was killed. For his gallant action, Hancock was awarded the Silver Star posthumously.

A few months later, as preparations for the capture of another island were under way, Lieutenant James P. Lowry, U. S. Naval Reserve, staff engineer from the Bell Telephone Company of Pennsylvania, earned a Silver Star

"for conspicuous gallantry and intrepidity as member of a reconnaissance patrol to a Japanese-held island in the Pacific area during the latter part of December 1943. With no knowledge of enemy strength or the attitude of natives to the Allied Nations, and with limited means of escape, Lieutenant (then Lieutenant, junior grade) Lowry unhesitatingly went ashore in the face of certain danger and, within an exceedingly brief space of time, had secured information concerning the strength of

Pfc. Elzie J. Hancock
Silver Star (posthumous)
Killed in action

Japanese forces and their equipment and had determined the most suitable beach for future landing as well as favorable sites for bomber and fighter strips. Discovered by the enemy and in danger of being captured by a hostile party possessing superior arms, Lieutenant Lowry fought gallantly, assisting in ambushing and killing three Japanese, wounding one and putting the remainder to flight before struggling back through heavy surf to the rendezvous with a friendly craft. His outstanding skill,

heroism and resourcefulness in the successful execution of a vital mission were in keeping with the highest traditions of the United States Naval service."

A very recent report from Normandy tells of the Silver Star won by First Lieutenant Robert Hunter, Cavalry, U. S. Army, a lineman from the Pennsylvania company, who has also been awarded the Bronze Star Medal.

CAPT. JAMES F. DEVINNEY
Distinguished Flying Cross with two Oak Leaf Clusters, Air Medal with four Oak Leaf Clusters
A prisoner in Germany since late 1943

"On July 12, 1944, the tank platoon commanded by First Lieutenant Hunter came under very heavy artillery and mortar fire, resulting in the death of one tank commander and the wounding of several men. Although he was wounded, First Lieutenant Hunter dismounted and, completely ignoring the danger involved, reorganized and led his platoon in a sustained attack, together with certain infantry elements. Only after the tanks had been withdrawn did he submit to medical treatment. The extraordinary heroism and devotion to duty displayed by First Lieutenant Hunter reflect great credit upon himself and the military service."

AWARDS of the Distinguished Flying Cross for heroism or extraordinary achievement in aerial flight have been reported for 101 Bell System men in the Army and for two in the Navy. One of these men, Captain James F. DeVinney of the Army Air Corps, an installer from the New Jersey Bell Telephone Company, has earned this award three times and is also the holder of the Air Medal with four Oak Leaf Clusters. That medal was first given for bombing missions over Europe early in 1943, when DeVinney became a First Lieutenant. On April tenth of that year, he was wounded but returned to duty within a month and, following another promotion, won his first D.F.C. a few days later for outstanding achievement while serving as group bombardier during a raid on

"a highly important military objective. Displaying great courage and skill under most hazardous conditions, Captain DeVinney, knowing that the bombing effort of the entire group depended on his accuracy, released his bombs directly on the target."

Within two months, an Oak Leaf Cluster to the D.F.C. was awarded for a raid over Sicily and three weeks later, on August first, the second Cluster was won in the long and hazardous raid on the Ploesti oil field. Given the choice of an immediate furlough or of further promotion on completion of two more flights, he undertook the flights, was shot down on the first one and reported missing

on August sixteenth, and a prisoner in Germany in December.

As pilot of five different British Spitfire fighters on 110 missions over Tunisia, Pantelleria, Sicily and Italy, Captain Donald J. Keith of the Northwestern Bell Telephone Company's accounting department has been awarded the D.F.C. in addition to the Air Medal with no less than eleven Oak Leaf Clusters. As the D.F.C. citation states,

"Throughout the North African and Sicilian campaigns, Lieutenant Keith has displayed outstanding courage and devotion to duty. On 10 June, 1943, while flying on a twelve-aircraft mission over Pantelleria, his squadron was attacked by more than twenty enemy fighters. When his wingman was forced out of position by six Macchi 202's, which attacked him from the rear, Lieutenant Keith unhesitatingly, and without protection himself, climbed toward the six enemy aircraft and, with a difficult head-on shot, destroyed the leader. Exploiting the advantage of surprise, he dispersed the five remaining Macchi's and saved his comrades from imminent destruction. On many combat missions his aggressiveness and consistent military proficiency have reflected great credit upon himself and the Armed Forces of the United States."

Missing in action since August, 1943, Lieutenant Lloyd O. Hendrix of the Southwestern Bell Telephone Company's plant department had won the Air Medal with eight Oak Leaf Clusters and the Distinguished Flying Cross

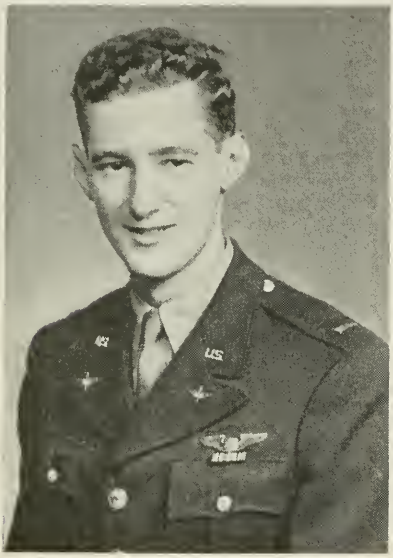
"for extraordinary achievement . . . as pilot of a P–38 type aircraft. On 18 July 1943, while escorting an air-sea rescue plane off the west coast of Italy, Lieutenant Hendrix sighted a formation of fifteen JU 52's flying at zero altitude toward Sardinia. After calling out their position, Lieutenant Hendrix attacked the enemy aircraft from the rear. Displaying exceptional flying skill and highly accurate marksmanship, he destroyed four of the transports in less than five minutes, and his comrades shot down the remaining eleven. Lieutenant Hendrix's cool efficiency in combat has reflected great credit upon himself and the Armed Forces of the United States."

No report has been received of the specific reason for the D.F.C. award

Lieut. Lloyd O. Hendrix
Distinguished Flying Cross, Air Medal with eight Oak Leaf Clusters
Missing in action since August 1943

to Major Emmet J. Thiesen, also holder of the Air Medal and several Oak Leaf Clusters, and a lineman from the Michigan Bell Telephone Company, but his skill as a pilot and the toughness of the conditions under which he flies are demonstrated by the fact that he is the personal pilot for Lieutenant General Joseph Stillwell in the remote and mysterious Burma-China area.

German submarine nests in the Atlantic ports of southern France have made the Bay of Biscay an essential area for long-range, hazardous Navy bomber patrols despite constant danger of attack from enemy fighter groups. Near this "Junkers' junction," two Bell System Navy lieutenants earned their D.F.C.'s in September, 1943. One of these men was Lieutenant (j.g.) Robert L. Bedell



CAPT. B. DONALD HANKS
Air Medal with six Oak Leaf Clusters
Missing in action since April 1944

of the commercial department of the Chesapeake and Potomac Telephone Company of West Virginia, who

"while his plane was under savage attack by eight twin-engine hostile fighters . . . rendered invaluable aid to his patrol commander in evasive tactics which enabled the gunners to inflict considerable damage on opposing aircraft. Although the big flying boat was set afire during the course of the engagement, her starboard engine knocked out and rudder shot away, he helped bring her down in a precarious crash landing at sea. Swimming clear of the burning plane, he assisted two wounded crew members aboard a rubber life raft which was leaking badly from gunfire, and by means of his own lung power managed to keep them safely afloat. His gallant spirit of self-sacrifice, maintained with disregard of personal safety, was in keeping with the highest traditions of the U. S. Naval Service."

Seven other men went down with the plane, all of them probably killed by gunfire before the landing. Bedell and his two companions, both of whom were wounded, were picked up by a rescue launch eighteen hours later.

In the other action, the assistance of Lieut. (j.g.) Paul B. Kinney, a traffic department man with the Ohio company, to his commander on a patrol bomber enabled its gunners to shoot down one and cripple three more of the six twin-engined attacking fighters.

"Although his own plane was set afire, her flying instruments rendered inoperative and her four engines badly damaged, he nevertheless carried on, despite painful wounds, until the big flying boat had successfully eluded the remainder of the enemy and landed safely at sea. His superb airmanship and courageous devotion to duty were in keeping with the highest traditions of the United States Naval Service."

In this instance, too, the plane quickly sank but the nine men aboard, despite injuries and high seas, covered seventy miles by paddling and sailing a rubber life raft and reached shore two days later. Six months later, Kinney won a Gold Star in lieu of a second D.F.C. for his skillful assistance to his commander in an action which probably sank an enemy submarine.

FOUR Bell System men are known to have won the Soldiers Medal and three the corresponding Navy and Marine Corps Medal. Although award of these medals does not involve actual conflict with the enemy, they have been given for actions requiring a high degree of heroism and skill. Typical of such action was that of Donald C. Bradley, Motor Machinist's Mate First Class, a lineman from the Illinois Bell Telephone Company, who won the Navy and Marine Corps Medal

"for extremely heroic conduct as a crew member of the U.S.S. LST 379 during the amphibious attack on the Island of Sicily, July, 1943. When the forward falls carried away as the assault boat descended to the water and the crew and Army personnel were thrown into the treacherous sea, Bradley unhesitatingly dived over the side of his ship and went to the assistance of the soldiers struggling under the weight of their equipment. Although handicapped in his gallant action by darkness and tremendous swells, he employed a life raft so skillfully that he was able to bring a number of the men to cargo nets, lines, and ladders on the vessel's side. Through his cool courage in a dangerous situation, he contributed to the expeditious rescue of the Army personnel and thereby enabled them to continue an important mission."

THE BRONZE STAR MEDAL, the newest decoration of the United States Armed Services, was established in February, 1944, for heroism or meritorious achievement not recognized by a higher award and not involving aerial flight. Of the thirty Bell System men in the Army and two in the Navy reported as recipients of this award, a substantial number have won it for communications work. Typical of this group is First Lieutenant Arthur W. Stillwagon of the Signal Corps, from the Michigan company's plant department, who commanded a construction platoon during the major part of the campaign in Sicily. Landing with one of the early groups, he and his men at first were subject continuously to strafing from enemy aircraft, and later, in order to keep pace with the advance, worked under artillery fire and through uncleared mine fields.

LIEUT. (J.G.) JOSEPH D. MCLAUGHLIN
Purple Heart (posthumous)
Killed in action

"The resourcefulness, untiring devotion to duty, and inspiring leadership continually exhibited by Lieutenant Stillwagon was outstanding throughout the campaign."

THE AIR MEDAL, given for meritorious achievement in aerial flight, has been won by 248 Bell System men in the Army and four in the Navy, and 588 Oak Leaf Clusters for repeated achievements have been awarded to

these individuals. Winner of six such clusters to his Air Medal, Captain B. Donald Hanks, a repeaterman from the Mountain States Telephone and Telegraph Company, "exhibited great courage and untiring energy" during sustained combat missions over enemy territory in the South Pacific, in many of which he acted as flight leader. A fighter pilot in the area from September, 1943, until April, 1944, Hanks has been missing in action since that time.

THE PURPLE HEART, established by General George Washington in 1782 as the Badge of Military Merit, this country's first military decoration, was revived in 1932 on the 200th anniversary of his birth and now is awarded for wounds received in action. Reports of its award are clearly incomplete, but, in addition to the many wounded, there have been 171 Bell System men killed in action in defense of their country to whom this award has been made posthumously. Among them is Lieutenant (j.g.) Joseph D. McLaughlin, an equipment installer from the New England company, who as commander of a P.T. Boat in the South Pacific for several months gallantly carried forward the seafaring tradition of that region. Participating in at least twenty-four engagements with Japanese destroyers and barges, he helped to sink several of the barges during their island-to-island retreats in the Solomons.

Purple Heart

"As new PT bases were established to cut down the operating range, he and his crew moved to stay right on the heels of the Japs attempting sea-borne evacuations."

Finally, in an engagement on November 14, 1943, he was instantly killed; and his men, on a nearby picturesque island, set up a sign bearing the words, "McLaughlin's Grove" in memory of a gallant comrade and leader.

AS WE acknowledge the courage, skill, and self-sacrifice of these men from the Bell System companies in the United States, it is fitting that we pay tribute, too, to those whose longer fight we joined, from the Bell Telephone Company of Canada, our near neighbors in arms and our associates in time of peace or war. Reports of decorations to twenty-three of its employees on military leave have been received. One of these men is Commander A. R. E. Coleman of the Royal Canadian Navy, who was Montreal buildings superintendent when called to service on September 10, 1939. Commander Coleman, who served on British submarines and destroyers in the first World War and later as first officer on a passenger liner, was made commanding officer of a Canadian cor-

vette assigned to convoy duty during the Battle of the North Atlantic. In the fall of 1942, his ship rescued fifty-four men from a torpedoed merchantman, in spite of heavy seas and continued threat of submarine attack. Early in 1943 his corvette, the *Ville de Quebec,* destroyed a German submarine in the Western Mediterranean. Brought to the surface by depth charges, the submarine was first attacked by every gun of the circling corvette and then rammed just forward of the conning tower, with such force that a gun was hurled overboard. The submarine immediately sank. For this action, Commander Coleman received the Distinguished Service Order and was praised in General Eisenhower's communiqué. He is now in command of the principal Canadian Naval Base on the Pacific Coast.

COMDR. A. R. E. COLEMAN, R.C.N.
Distinguished Service Order (*Canada*)
On active duty

The resourcefulness and courage of an installer from northern Ontario are described by the Canadian Company as follows:

"An enemy fighter plane attacked a giant R. A. F. Lancaster over the Alps. The navigator was killed and the pilot so badly wounded that he was unconscious. Flight Sergeant Allan W. J. Larden, bomb aimer, who had never flown a plane for more than a few minutes before, lifted the pilot from his seat and took over the controls. The enemy fighter was still at work and the big bomber had three damaged engines and some thirty-six bullet holes before Larden brought it down from 15,000 to 3,000 feet and headed for North Africa, five hours' journey away. He tried to jettison the bombs, but the release mechanism had been hit and would not work. Flying low over the Mediterranean he managed to make a perfect belly-landing near a town in North Africa. His good judgment and able handling of the plane is receiving the highest commendation and he has been awarded the Conspicuous Gallantry Medal, the highest award next to the Victoria Cross which can be won by a non-commissioned officer."

THIS is the record which, inadequate, incomplete as it is, shines forth. We pay homage to these Bell System workers as men whose deeds, at the cost or risk of their lives, are undying. For them, for the thousands of other telephone men and women in the armed services, and for the millions of their comrades-in-arms, we at home cannot fail to give every effort until their work is done and their purpose won.

Modern Electronics, Which May Be Said to Have Begun When H. D. Arnold Produced the First High-vacuum Tube, Is a Big Factor in Electrical Communication

The Rôle of Electronics in Telephone Service

Austin Bailey

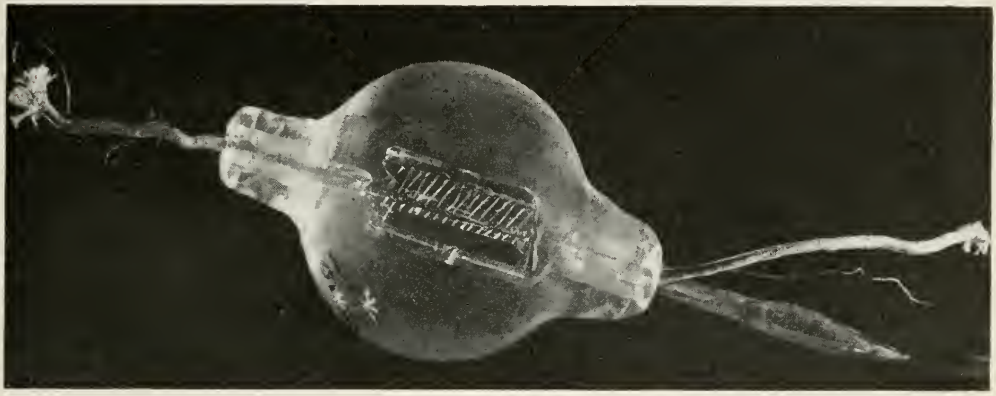
THE WORD "ELECTRONICS" brings to the mind of the general public today an association of magic, much as did the word "radio" during and after World War I. There is speculation about secret war weapons utilizing the science of electronics; popularized articles appear about its miracles; it makes headlines in advertisements and the press. It is one of the important catch words of the day.

What, basically, is electronics, then? Is it some spectacularly sudden achievement of science, a case of "something new has been added" to the realm of human knowledge?

Scarcely so! Spectacular it may be in some of its recent applications, particularly in warfare; and in this inventive and ingenious age some of its adaptations to peaceful use in the future may be even more significant. But for some 30 years people have been familiar with and have benefited in various ways by the practical applications of electronics on the part of those who work in the fields of electricity, chemistry, and physics —even though to the vast majority of people the very word until recently may have been unfamiliar.

Specifically, for more than a quarter of a century electronics has been helping the telephone to extend its reach, to carry conversations more clearly, to perform many of its operations better or faster or more economically. How electronics serves the telephone industry, and thus the telephone user, quite naturally requires some explaining—which can be deferred momentarily in favor of another and fundamental explanation: why and how electronics has been serving thus and for so long. It is because the late Dr. Harold D. Arnold of the Bell Telephone Laboratories, in his search for some suit-

able means for amplifying the weak electrical currents of communication systems without otherwise altering their characteristics, early recognized the importance of employing a high vacuum in which to control free electrons. It was on November 1, 1912, that he expressed the opinion that the operation of a certain device, the audion of Dr. Lee de Forest, would be improved by employing the highest obtainable vacuum; and that date, perhaps more than any other, marks the beginning of modern electronics.



An historic milestone along the road of electrical communication: the late Dr. Arnold's first high-vacuum tube

In telephone parlance, the device employed to amplify weak currents on telephone lines is known as a "repeater." Its purpose is merely to make a very small amount of current control, or impress its characteristics on, a current of much greater strength. In this way, the telephone current coming into the repeater, weakened from its journey over the wires, is started on its way again with renewed strength. An analogy which illustrates this purpose lies in the fact that a child, by exerting a small amount of effort, may turn a valve of a steam or hydraulic turbine, and can thus control the immense turning power of the machine.

So successful were the tests of Dr. Arnold's first high-vacuum-tube repeater that by 1915 repeaters of this type were used on the circuits employed for the first transcontinental telephone service. In the same year the same type high vacuum amplifier tubes were likewise employed for the first transmission of speech by radio across the Atlantic and, three years later, for the first practical carrier telephone system. Electronics had been put to work. It was already much more than a laboratory equipment in the Bell System.

As is the case now, so in World War I, the knowledge, energy, skill and resources of the Bell System

were turned to the one important task of contributing an "all out" effort toward winning the war. All the development effort was turned to perfecting the then modern communication equipment for the armed forces—radio-telephone to airplanes, improved telephone systems for ground troops, fire control systems for ships, submarine detectors and other similar equipment. Electronic tubes played an important part in many of these devices. The manufacturing facilities of the Western Electric Company and of other manufacturers were taxed to the utmost to fulfill the requirements.

When the armistice came in 1918, development of electronic instrumentalities for use in the telephone company was again undertaken. In 1923 satisfactory one-way radio telephone transmission to England was demonstrated which led to the opening of the first public transoceanic radio service at the beginning of 1927. Commercial telephotograph service was inaugurated in 1924, and the following year nation-wide network broadcasting circuits were made available. Other events, such as intercity one-way television in 1927 and the 1930 two-way television demonstrations in New York City are mile-stones in the application of electronic techniques in the Bell System.

Electron, Proton, Neutron

To acquire an understanding of—or at least a speaking acquaintance with—the principles of harnessing free electrons to do many kinds of work makes no excessive demand upon even the non-technical reader.

Let us make a start, then, with the atom: once considered the smallest indivisible piece of matter, it is still held to be the smallest piece of matter which retains definite chemical and physical properties. Scientists now recognize, however, that atoms themselves—and thus all matter—are composed of several kinds of basic particles put together in various combinations.

The simplest atom is that of the element *hydrogen* and it is made up of one electron and one proton. The electron is a negative elemental electrical charge and the proton is a positively charged elemental particle. The most complicated stable atom known is that of the element *uranium*, which contains 92 electrons, 92 protons, and the most common variety also contains 146 neutrons. Neutrons are uncharged elemental particles.

In all the elements, the electrons and protons are bound together by electrical forces; *but an external force which is sufficiently great can overcome the electrical forces which bind them together, and thus an electron becomes a "free electron"*—and as such available to joint the procession of its fellows and become part of an electric current. When that current flows in a wire, its useful applications are the subject-matter of electrical engineering—as the art was known up to a few years ago. Within the last generation, however, a new branch of the art has grown up, called *electronics* and dealing with the flow of electrons through a vacuum. For the purpose of this article, such an electron will be called a "free electron," although strictly speaking the term also includes electrons in wire-borne currents.

Any free electron is just like any

other electron, regardless of its past history. It has no genera nor species. It is, quite simply, an infinitesimal particle of negative electricity.

Electrons can be "freed" in a number of ways. The elaborate "atom smashers" in scientific laboratories do it, but so does the hot filament in an electric light bulb. Light falling on the surface of certain metals liberates electrons from those metals; certain so-called radio-active substances spontaneously liberate electrons in the process of disintegration; and still other methods have been found to produce free electrons.

Basic Principles

ONCE an electron has been "freed," it can be made to move through space at varying speeds and over controlled paths—provided nothing gets in its way to arrest its speed or divert it from its course. For example, Figure 1 pictures a filament, F, heated by the current flowing through it from the battery, A. The hot filament frees electrons and if a battery, B, is connected between the filament and a plate, P, inside an evacuated space in such a way that the plate will be positively charged with respect to the filament, then the "free electrons" will be attracted toward the plate and cross through the vacuum space to strike the plate. This is a flow of electric current and is shown by the current indicator, I. However, if the vacuum is not perfect there will be some residual gas molecules and atoms floating around in it. These are relatively very heavy in comparison with the free electron, and should such a molecule or atom happen to get in the line of flight of the electron a collision will occur, and the electron may bounce off it, combine with it, or discharge more electrons by overcoming the forces which bind them within the atom.

Today, thanks to Arnold, we know that the way to obviate such collisions is to reduce the possible sources of interference, and the liberation of free electrons *in high vacua* is fundamental to electronics—since under that condition the occurrence of collisions with residual gas atoms and molecules is reduced to the minimum.

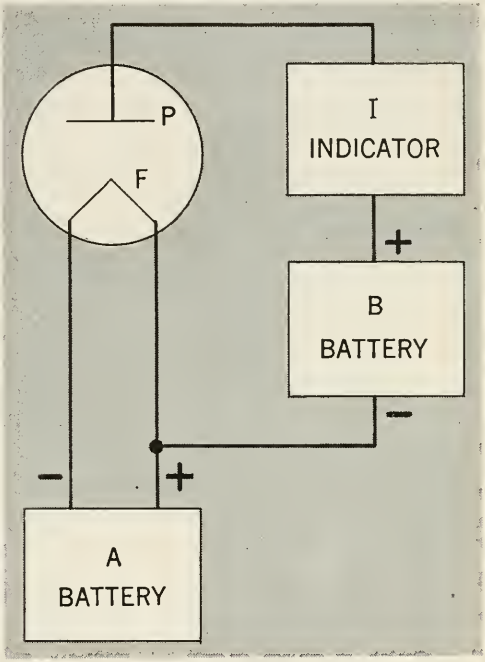


FIG. 1. A diagrammatic representation of the elementary principles of the vacuum tube

Handing On the Torch

MANY SCIENTISTS before and since Arnold have contributed to today's

knowledge of free electrons and how to produce, control, and utilize them.

In 1883 Thomas A. Edison was experimenting with the incandescent electric lamp. He had used in the process of manufacture of the carbon filament a third wire sealed through into the partially evacuated space. The filament was heated by direct current and he observed that if a meter was connected between this third wire and the positive end of the filament a current would flow through the meter while if connected to the negative end of the filament no current would flow. This phenomenon came to be known as the Edison Effect. It was, as is known today, the flow of free electrons through the vacuum as illustrated in Figure 1.

In 1904, John Ambrose Fleming with the knowledge of Edison's experiments employed the "free electrons" from a hot filament in a partially evacuated bulb to rectify high frequency electric currents. A rectifier is any device which will take an alternating current, one which flows first in one direction and then in the other repetitiously, and change it into a direct current which always flows in the same direction through the electrical circuit. Fleming was working as technical advisor to Marconi at the time and the "Fleming Valve," as his device was known, was the first practical application of the Edison Effect. The Fleming Valve was in no sense an amplifier, it was simply a hot filament to produce free electrons and a plate to collect the electrons which were freed. In place of the battery, B, in Figure 1 he applied the alternating current of radio signals. This, of course, caused a current to flow through the Fleming Valve while, during each alternation, the plate was positive with respect to the filament, but no current during the equal interval of time that the plate was negative with respect to the filament. In this way the radio signals were changed to direct current and the device was a detector of the radio signals.

Dr. de Forest in 1906 conceived the idea of interposing an insulated wire grid between the filament and the plate of the Fleming Valve. His invention was known as the audion. The grid acted to control the flow of electrons from the filament to the plate. Primarily its practical use was as a detector, which employs alternating current as a means to control direct current. In effect it is like a rectifier in that alternating current is put into the device and direct current is taken out of it. However, it is unlike a rectifier because the direct current is supplied by a source other than the alternating current itself which only controls the flow from this other source. Frequently the words "rectifier" and "detector" are used interchangeably when only the end result has significance. Radio frequencies were impressed between the grid and the filament of the audion while the connection to the plate was the same as shown in Figure 1. Because of the position of the grid this device was a more sensitive device than the Fleming Valve, the controlled current in the plate circuit, of course, being supplied by the battery, B, instead of directly by rectification of the weak radio signals.

These two contributions to practical electronics, the Fleming Valve and

the de Forest Audion, were of particular importance for their ultimate consequences upon telephony. Meanwhile, however, just as important contributions were being made in the field of scientific electronics. In the research laboratories over the world, discoveries and measurements of free electrons and their behavior came in an ever increasing number.

J. J. Thomson in 1897 succeeded in measuring the mass of the electron, small as it is, and likewise advanced the electron theory. This was followed by the brilliant work of Professor R. A. Millikan in 1910 in establishing the electrical charge of a single electron and thereby proving that every electron is just the same amount of electrical charge as every other electron. These and many other scientists have contributed much to clarify our knowledge about free electrons and their behavior.

At the right in this picture are some of the 500 transmitting amplifier tubes used in projecting the human voice across the Atlantic Ocean for the first time, from Arlington, Va., in 1915

Of course Arnold had knowledge of the electronic developments which had been accomplished when he made his epochal development. The telephone company engineers, with a vision of extending the range of communication, had been seeking for a good repeater. At least two other

types had been tried with varying degrees of success and when in 1913 the vacuum tube repeater became available it was at once apparent that this new electronic tool was destined to revolutionize the art of communication.

Figure 2 illustrates the most elementary form of this high vacuum tube repeater with a single grid, G, to control the flow of "free electrons" in the vacuum space. These electrons come from the hot filament, F, and travel through the space to the plate, P. Other necessary parts of the system to make a repeater of alternating currents, such as the currents set up in an electrical circuit by a telephone in use, are also indicated in the figure. These are the input circuit, I, where the low intensity alternating current signals are supplied, and the output circuit, O, where the amplified signals are taken from the repeater after passing through the transformer, T, which separates the alternating components of the current from the combined direct and alternating currents in the plate circuit. Besides this there are three current supply sources, A, B, and C, which are required for operation of the repeater. The A source heats the filament and "frees" electrons; the B source drives these electrons toward the plate; the C source is a

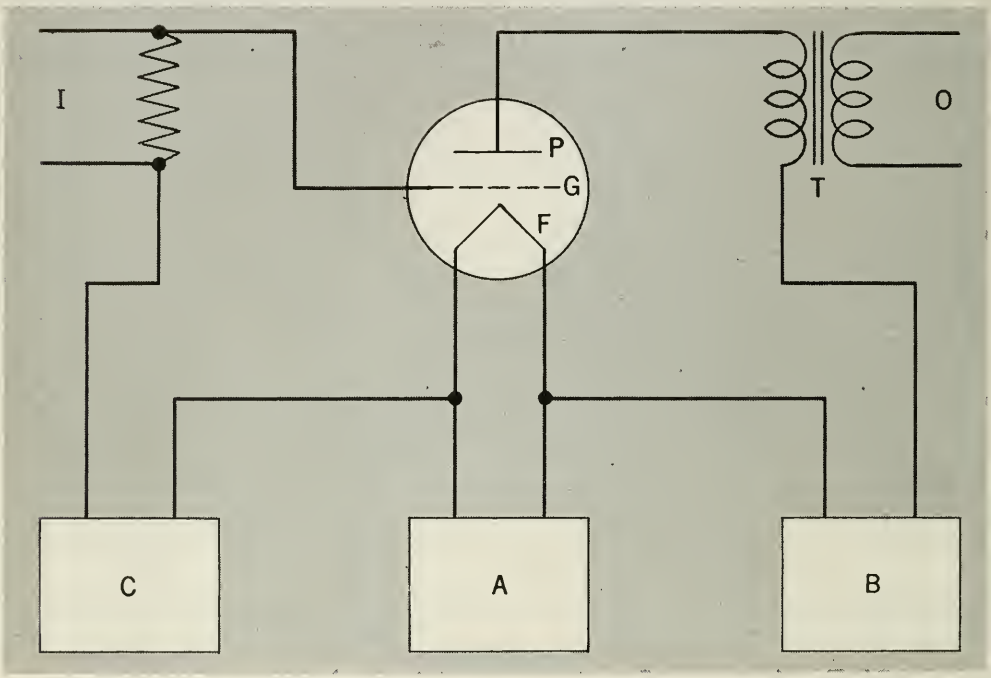
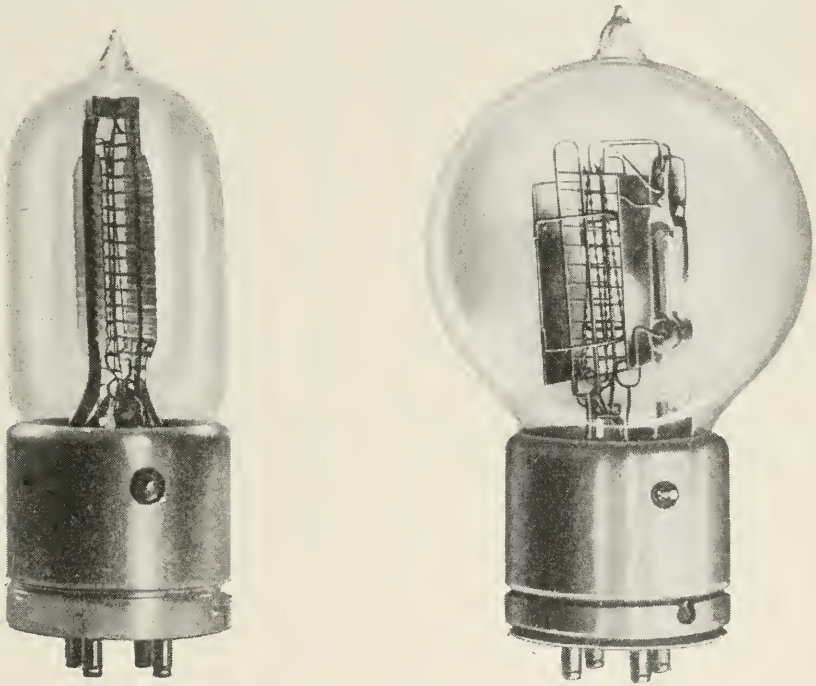


Fig. 2. A diagrammatic representation of the elementary principles of the telephone repeater. For explanation, see the adjoining columns

bias or balancing means which stabilizes this electron flow.

Tubes of Many Types

In the Bell System there are now employed in connection with operating telephone services a total of around 290 different types of vacuum tubes. The equipment units in which these are employed are too numerous to mention. Telephone repeaters, carrier telephone systems of various types, ringing equipment on toll lines, radio telephone service to foreign countries, to ships, and across natural barriers, are only a few of the applications of the electronic art employing vacuum tubes. Applications of electronics in the telephone plant embrace a wide variety of uses. Not only are vacuum tubes used as amplifier elements, but they are used in oscillators to generate electric currents, in modulators and demodulators to mix alternating currents of different frequencies and produce new frequencies, and in many other ways.



Signal Corps receiving (left) and transmitting (right) tubes, made by the Western Electric Company, of the types used in the first World War

In size these tubes vary according to usage, from the diminutive ones used in hearing aids to the large water-cooled tubes required for the powerful radio amplifiers in the overseas radio telephone transmitters.

They vary in numerous other ways beside size, since special kinds of vacuum tubes are required to do many

different kinds of jobs. Tubes which have more than one grid between the source of electrons and the plate have valuable advantages in many cases. Numerous types of tubes are made in which the source of electrons is not the hot filament but a so-called cathode which is indirectly heated by the filament. This cathode has better properties in freeing electrons when hot than does a filament. Then in phototubes the electrons come from a metal plate, freed by the energy of the light which falls on it. Cold cathode tubes in which the free electrons are produced by breaking apart atoms of the gas remaining in the tube are sometimes used as rectifiers. Most recently Dr. A. M. Skillett of Bell Telephone Laboratories has developed a tube in which free electrons which are produced as "secondary electrons," splashed out of a metal plate by bombardment with a stream of electrons from another source, are employed to give a trigger action to the tube which makes it behave like a relay to open and close a circuit.

So diverse are the types of electronic tubes which have been devised by scientists and inventors that even to catalogue them would be a stupendous task. New and secret types have recently been developed for military purposes. After the war is won, many of these new types may be found to have value in telephone communication systems.

A Modern Aladdin's Lamp

While we are here concerned primarily with the science of electronics as it is applied as a daily commonplace to many phases of the operation of the telephone service, electronics touches the lives of most people in many other ways and performs other seeming miracles.

Miraculous is scarcely too strong a word, indeed, when one considers the kind of "material" with which scientists work. The mass of the electron is very small indeed, less than one eighteen hundredth of that of a single hydrogen atom. And its size? Well, scientists tell us that the size cannot be determined because of the nature of an electron. A pure guess as to size, based on assumptions which are known to be questionable, yields the result that somewhere near 25,000,000,000,000 touching one another in line would be about an inch long; and that such a line of electrons, extended all the way from the earth to the sun, would have a mass no greater than that of an ordinary pin. These comparisons are of interest largely because they help to fix in our minds how really small an electron is.

There are other strange things about an electron that are outside our ordinary concepts of physical things. It is possible, for example, to cause an electron to travel at a speed almost as great as the speed of light or radio waves, which, by the way, is 186,000 miles a second. When electrons travel at high velocity scientists tell us that the apparent mass of the electron is greater than when it is moving only at moderate speed. These are the strange particles which are a part of every thing around us and which, through their employment, have enabled man greatly to extend his ability to perceive the world about him.

With the aid of electronic devices, man not only can hear over a tele-

phone circuit sounds which have occurred at great distances from him but can hear sounds which are so weak that without amplifiers their presence would be impossible of observation. Sounds which exist outside the frequency range of the human ear can be transformed to frequencies capable of causing perception so man can "hear them" or at least can hear something bearing a known relation with the original sound.

Television, which even in its present infancy has enabled man to see things as they occur at distant places, is dependent almost entirely on the application of electronics. The x-ray, which is produced with electronic equipment, permits man to see through opaque objects, to discover flaws inside large metal objects, and otherwise to extend the sense of vision. The electron microscope, another electronic device, has enabled man to see objects which are 100,000 times smaller than could be seen before its invention. Electronic equipment has made possible distinguishing 2,000,000 shades of colors, a feat not possible for the human eye. With electronic devices continuous observation of phenomena can be maintained; they can count the number of parts coming from a production line or act as a silent watchman or door tender. And electronic devices are used to make some rapidly moving objects which the eye cannot follow either apparently to stand still or to move quite slowly, so that the eye can follow the motion.

Certain machines which formerly were controlled by the skill of the operator and his sense of touch are now controlled electronically to a precision far beyond that of the most skillful operator. Surface roughness and similar properties previously observed by touch are now measured electronically.

Taste and smell?—well, there may be electronic devices to extend these also.

CONTINUOUSLY there are about 1,500,000 vacuum tubes in operation in the Bell System. The annual requirement for replacements is about 250,000 and would be much greater except for the ingenuity of the electronic research engineer in designing tubes with long life as one primary objective. In such use electronics is no remote scientific mystery but a willing servant of a great industry, taught by the scientists at the Bell Laboratories—through study of what has gone before and their own developments—to perform in many ways which make service better, effect economies, and so benefit the telephone user every time he picks up the receiver to call the neighbor next door or some far distant corner of the earth.

When, under the impetus of a hurricane, salt water attacks dry land, any resort community in the way must expect to suffer

Such varied craft as barge and sloop effectively block this highway

No train ran here for several days, after the ocean had undermined roadbed and overflowed tracks. Telephone cable stands at left

For the Second Time the Bell System Demonstrates Its Great Recuperative Powers as a Tropical Storm Gets Off the Beam and Damages the North Atlantic Seaboard

A Hurricane Strikes Again

Judson S. Bradley

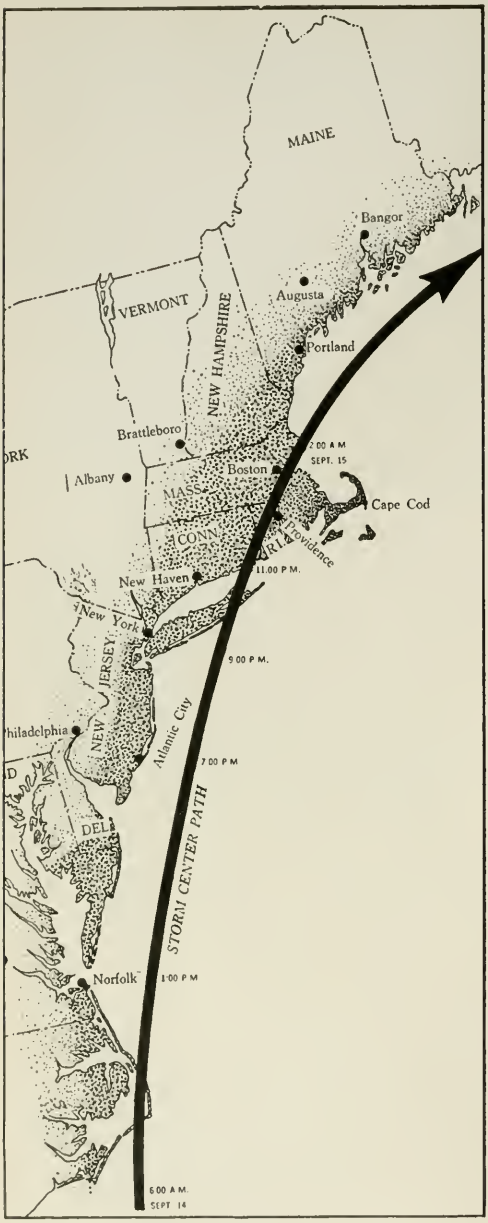
THE second tropical hurricane to strike the North Atlantic states in six years, chaperoned for a week by the U. S. Weather Bureau and reported on almost hourly during most of that period, lived up fully to its advance billings when it ravaged the coast from the Virginia Capes to Maine on Thursday and early Friday, September 14 and 15.

The warnings which preceded it undoubtedly saved many lives and some property, and they certainly helped preparations for the enormous task of restoration; but not by one iota could they abate the force and fury of the storm. And anyone who was inclined at first to look upon it merely as an exceptionally severe "equinoctial gale" soon changed his mind when he saw or learned of the devastation along the New Jersey shore, for instance, the cruel loss of trees in cities, villages, and forests, or the wreckage of houses and piers and small craft which littered Cape Cod almost from end to end in tangled confusion.

The hurricane of September, 1944, inevitably evokes comparisons with its predecessor of terrible and proud memories: the "New England hurricane" of September, 1938.* Broadly they have much in common. They have many differences of detail. To state that 414,500 telephones were put out of service by the 1944 blow, as against 597,000 in 1938, is to summarize both the likenesses and the differences; for while those totals are both very large, the former includes losses of eight Bell companies, while the latter is heavily weighted with figures from New England—which was much harder hit by the storm of 1938.

The figures for "stations out" in Virginia, Maryland, eastern Pennsylvania, and New Jersey last September testify to the more westerly course of the hurricane in those latitudes, while correspondingly fewer losses in upper New England indicate where it veered eastward and out to sea—instead of following again a course northward along the Connecticut River valley.

* See "The Bell System Meets Its Greatest Test," BELL TELEPHONE QUARTERLY, Oct., 1938.



HURRICANE OF SEPTEMBER 1944

AREA OF HEAVIEST DAMAGE

AREA OF LESSER DAMAGE

Long Island, eastern Connecticut, and Rhode Island were, for the second time in six years, victims of a fierce assault of nature whose like had not been experienced previously since 1815.

Other differences between 1938 and 1944 should also be noted here. Six days of rain in the former year had caused floods in many streams of New England and upper New York which did real damage even before that year's hurricane arrived. While the 1944 storm wind brought high and raging waves against shore communities and the entire coast, there was no single "tidal wave" like that which wreaked such great destruction in 1938. Nor did fire among weakened and collapsed structures bring the danger of conflagration which occurred in some communities half a dozen years ago.

NONE of this could be foreseen, of course, by those who were following tensely the reports and bulletins which preceded the eye of the storm northward: 9 A.M. on Thursday the 14th, over Cape Hatteras; 1 P.M. off Norfolk; 7 P.M. off Atlantic City; across the eastern tip of Long Island at 10 and into the Connecticut-Rhode Island shore by 11 P.M.; and southeast of Boston and out of Massachusetts to seaward by 2 A.M.

Such precautions as men may take against uncertainty they took before those hours struck. In some communities, which had learned their lessons the hard way in 1938, vehicles and pedestrians were forbidden the streets. In shore settlements, state or local police or perhaps the civilian defense organization ordered cottages evacuated—against the will, some-

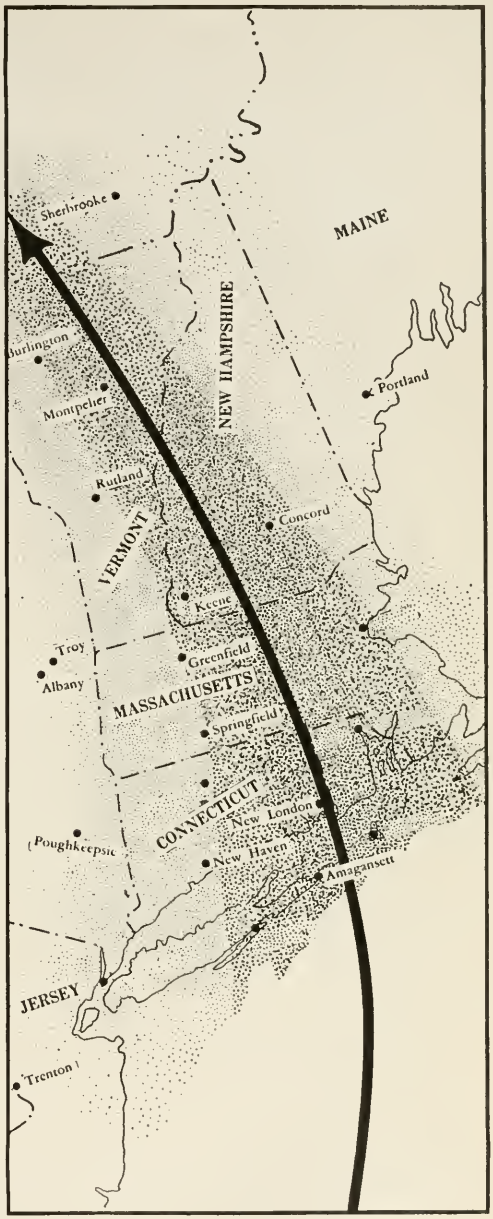
times, of residents who returned next morning to find placid waves lapping the sands where the day before a home had stood. In many a place in New Jersey, New York State, New England, school sessions were suspended, and anxious citizens made fast their awnings, took in the porch furniture, and looked up at the leaden sky or listened to the ominous warnings of the latest radio bulletin with foreboding.

Nor for telephone people was there any absolute prospectus of where or with what power the storm might strike. They knew from experience or report what a hurricane can do. They had had ample warning. There was but one course to pursue: expect the worst, make every sensible preparation, take every reasonable precaution—and stand by.

Braced and Set

DAYS OFF and vacations immediately impending were cancelled, so that full staffs might be on hand. That took place in practically every telephone unit in the threatened territory. So did the full charging of central office batteries, and the tuning up of standby power plants—or the obtaining of emergency charging apparatus. For without "juice," the voice of a telephone system soon wearies and gives out.

In one territory, scores of telephone trucks which had been put up on blocks, to conserve gasoline and tires, were made ready, before the storm's advent, for service on the road. In another area, all repair and construction trucks were brought in to central points and held there, for quick dispatch when and where the need became known. Again, other



HURRICANE OF SEPTEMBER 1938

AREA OF HEAVIEST DAMAGE

AREA OF LESSER DAMAGE

plant crews were sent home early with instructions to get some rest and be ready to report back to their local headquarters upon summons. Line personnel of the Long Lines Department was "alerted" from Key West to Boston.

The Long Lines Department also dispatched a portable radio telephone transmitting and receiving set from Denmark, S. C., to follow on the heels of the hurricane and bridge any gap in Long Lines wire circuits; but fortunately it was not put to use.

As word of the hurricane's approach became increasingly definite, state by state, items of plant supply were carefully checked, and loaded trucks from Western Electric distributing houses began to roll out to telephone company cable yards and stock rooms. So, in turn, trucks and trains ran from the merchandise departments of the Kearny and Hawthorne Works to replenish stocks at the distributing houses.

In the central offices, at test desks and power panels, other plant men kept vigil over their equipment—alert for first indications of the serious damage which was confidently expected.

As far as preparation was possible, plant forces were all braced and set.

The Calls Increase

MEANWHILE, the nearer the storm gyrated, the higher mounted local, toll, and Long Lines traffic. Augmented forces were at the switchboards, and of course dial calls clicked merrily through the apparatus. Near-record highs were established prior to and during the blow which were only to be exceeded by new records the following day.

Two occurrences are revealing. On Thursday, the day of the storm, 155,000 calls were made to the automatic weather reporter in New York City, and 135,000 to the similar service in Boston—both figures being higher than any previously reached. And in several communities along the Atlantic coast, local calling before and during the hurricane reached such a pitch that radio broadcasts were employed to ask people to telephone only for urgent reasons—lest the switchboards become too congested to put through true emergency calls if the need for them should arise. The immediate drop in the calling rate tells something, it may be, about the public's acceptance of the telephone's rôle in an actual emergency.

In each of the Bell System operating companies affected, one other unit, numerically small, stood by as the storm sped northward: the information and public relations department. The experience of 1938 had demonstrated that a public which is quickly and thoroughly informed about the steps being taken to restore service is a public which is patient and understanding and appreciative; and, along with the operating departments, those offices were manned at all hours and were able not only to keep newspapers and radio stations informed about the telephone situation but even upon occasion about the course and progress of the hurricane itself.

THERE is a sketchy word-picture, then, of conditions at any given locality upon the Atlantic coast within the territories of eight System companies, at the moment when a storm of horrendous but unknown power

impends. Observe, if you will, that only at the switchboards and in the dial equipment rooms is there great activity. Elsewhere is the poised calm of a coiled spring.

Then the wind and the rain begin, and quickly mount to fury: the wind in shrieking gusts that rise to 150 miles an hour and drive the torrents of rain in horizontal sheets. Along the shore the waves pound in with an inexorable might which alters, shifts, or demolishes most things which it encounters. Over the storm's wide swath, great trees are uprooted or snapped off.

Within two to four hours the storm passes, to be followed, in ironic contrast, by a calm sea and a bland and sunny day or starlit night.

But the trees, themselves victims, have wrought vast destruction to overhead wires and cables of every kind.

Three-way Damage

To telephone plant they caused damage in three ways last September. They crashed down upon cables, frequently rupturing them or bearing them to the ground. They knocked down "drop wires"—the connecting wires between the building and the main telephone line. They brought down live electric wires which "burned" telephone cables, melting the wires within or allowing moisture to penetrate or perhaps blowing fuses at one end of the line or the other. Of the 414,500 telephones knocked out of service, all but a relatively few were disabled directly or thus indirectly by trees which fell before the gale.

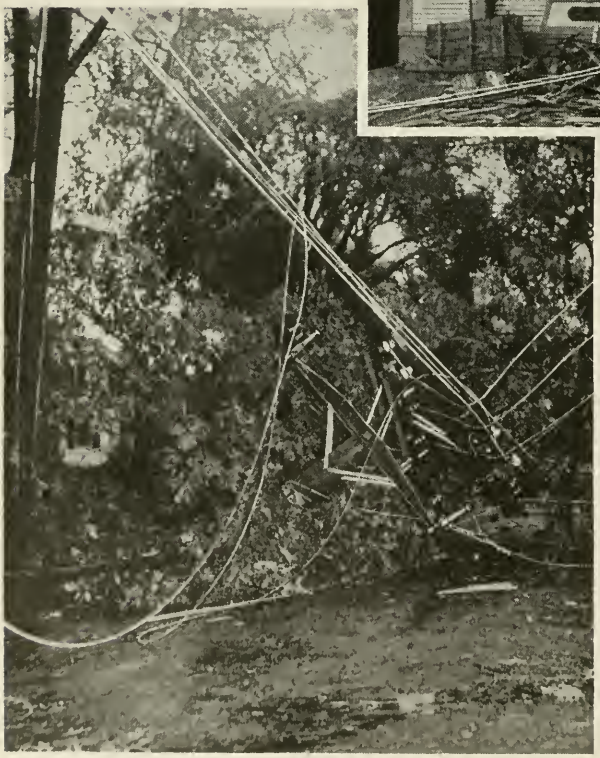
Comparison Between Hurricanes of 1944 and 1938

Telephones Affected	*Hurricane 1944*	*Hurricane 1938*
New England	132,000	400,000
Southern New England	60,000	106,000
New York		
Long Island	80,000	30,000
Bronx-Westchester	21,000	11,000
Upstate New York	2,000	15,000
New Jersey	92,000	35,000
Bell of Pennsylvania—Eastern	12,000	—
Chesapeake and Potomac—Md.	12,000	—
Chesapeake and Potomac—Va.	3,500	—
Total telephones affected	414,500	597,000
Employees borrowed from other areas or companies for storm restoration	950*	2,400
Vehicles borrowed	350*	620
Elapsed time to restore all telephones	12 days†	28 days†

* Excluding shifts of own men by New England and So. New Eng. companies.
† Temporary restoration in many cases.

EVEN relatively small trees sometimes produce a tangle of confusion as they go down

THIS is what the hurricane left of one church



TREE LIMBS, wire, and pole top and cross arms present a problem to the restoration forces

Yet surprisingly often a telephone line remained virtually intact while supporting a single big tree or even a row of trees which had bowed before the wind's violence.

The loss of such a great number of telephones is certainly an index of the storm's ferocity, but it is by no means the only consequence. Because electric light and power circuits are also vulnerable, nearly 400 telephone central offices were without "commercial" power for varying periods, but the emergency precautions mentioned earlier kept them all in service.

Forty-four communities were telephonically isolated for varying periods, and more than 1,000 toll circuits were affected; but the Long Lines Department's important circuits into and through the storm-smitten areas suffered little damage—thanks, no doubt, to such facts as that much of its plant along the eastern seaboard is underground, that a good deal of it was strengthened after 1938, and that gas pressure protected many of its main cables. Its New York traffic control bureau was a key point in making sure that toll circuits throughout the coastal area were working at their greatest possible efficiency, and a similar bureau of the New England company in Boston was correspondingly effective in its territory.

As THE hurricane passed, many things began to happen, telephone-wise. But one thing just kept on happening more and more, and that was telephone calls—local, toll, and Long Lines. Random figures will illustrate the point: local traffic 25 to 35 percent above normal at Boston and 60 percent above normal at Providence during the three days after the storm; 172,000 toll board calls in New York City on the Friday after, a 40 percent increase above average; and a Long Lines count of 87,576 in New York on the same day—also a 40 per cent increase. In Atlantic City on the day of the hurricane a working force of 130 operators put in 318 hours of overtime: the equivalent of 45 more operators.

Many people were anxious about friends or relatives, some had to place calls about hurriedly changed plans, and to others the hurricane was a major event and thus a topic for conversation. Every central office from Norfolk to Bangor had a new traffic record of some sort—or so it seemed.

What, then, of the people who couldn't make calls because they had no telephone service—the 25,000 customers in the New England company's New Bedford district, the 80,000 on Long Island, the 3,500 in Virginia, and all the others in between?

Organization, Standardization, Teamwork

NOW IT IS that the coiled spring, static no longer, begins to unwind, to exert its dynamic strength. Bell System manpower, skilled, intelligent, directed, takes up the task for which it has been poised. The storm is over—the trucks roll!

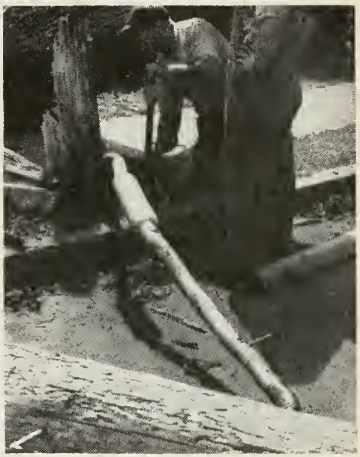
They can roll, of course, because there are planning and organization and supplies and standardization, yes, and System-trained men—and System-trained girls back in the offices keeping track of things—to restore so much plant to provide service to so many people. But that is the combination that can do it.

No aerial telephone plant is designed to withstand so great a weight, yet service did not fail here

A "power burn" was caused at the right-hand contact

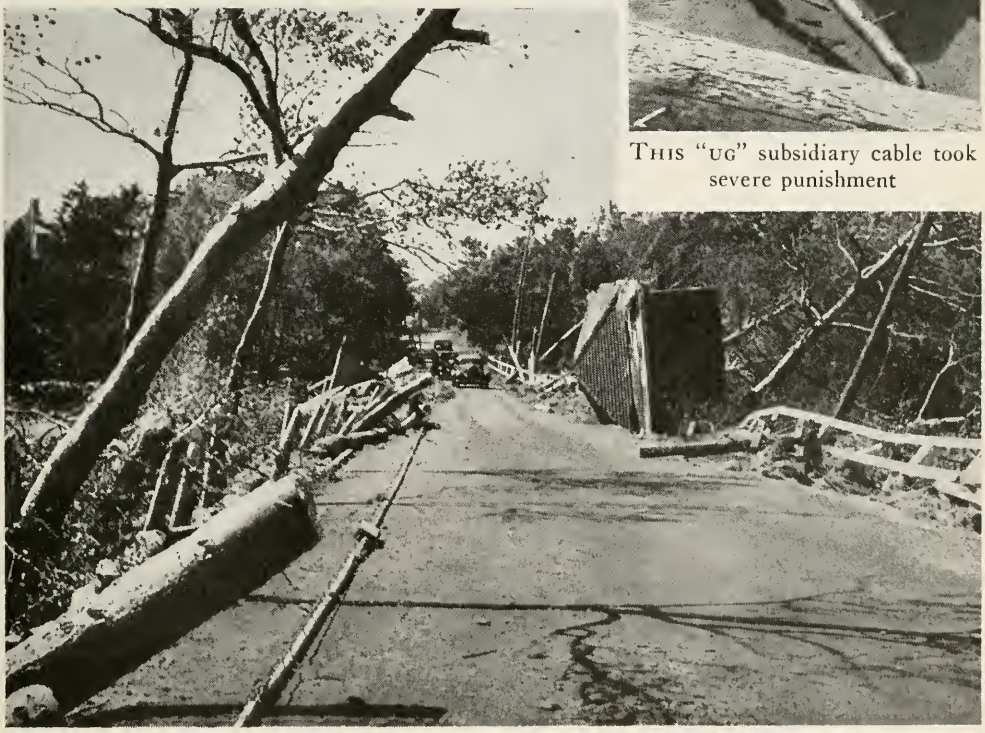
Wire services, as well as some one's home, suffered in this general smash-up

TELEPHONE CABLE and suspension strand could "take it" better, in this case, than could the trees



THIS "UG" subsidiary cable took severe punishment

THE telephone cable lying at the side of the road may still be carrying messages. Many others did so



From Bangor to Richmond, plant men swing into their stride: line and splicing crews, of course, installers and repairmen; but with them now are other helpers—engineers and mayhap commercial representatives, to gauge and report calamity's extent; central office men because they, too, can lend a hand; and a miscellany of recruits who once wore climbers or could wipe a splice and now pass up the office for a chance at the firing line again.

12,000 Men at Work

HERE IS a round and telling statistic to puff the proverbial pipe upon: during the period following the storm, about 12,000 employees were engaged in service restoration. These included nearly a thousand men, either shifted within their own territories by the companies affected or lent by other Bell companies as far west as Ohio to help with repairs in the badly damaged locations.

The New England company, with perhaps only a third as much damage in total as in 1938, found its greatest losses were in the vicinity of Buzzards Bay and on Cape Cod. As soon as a hasty survey showed what the situation was, that region—the New Bedford district—was organized on a divisional basis, with local areas becoming temporary districts in charge of plant superintendents, brought in to supervise the men from other districts who rolled in with their trucks and tools from as far away as Bangor to the east and Rutland to the westward. Many a cable waited for restoration until some huge tree could be removed, many a pole waited for a tangle of electric light wires to be straightened out before a telephone wire could be hooked up to it. And many a telephone will not be recovered nor service restored because both house and telephone are gone—the house's wreckage to join the ocean's flotsam, the instrument to rest on the ocean's floor.

To find food and housing for a couple of hundred extra men at shore resorts out-of-season was just one more complication, and, like others, it was solved. To local residents and late-staying summer visitors, who noted and commented favorably on the number of telephone trucks in evidence up and down the Cape, service was restored—often on a temporary basis—by the end of the week following the storm.

Storm damage in Connecticut, the territory of the Southern New England Telephone Company, was likewise less by perhaps half than in 1938 and, since it was fairly evenly distributed throughout that relatively small area, the company found that it had to do little shifting of its forces. As elsewhere up and down the coast, skilled repair forces worked long daylight hours, while others spent night shifts in testing, planning, and recording, to get service back within a week to the 60,000 silent telephones.

IN NEW YORK and New Jersey the opposite situation prevailed: those two companies, which, broadly speaking, had escaped with somewhat lesser damage in 1938, had now caught the full fury of 1944's hurricane, and the destruction this time was severe. In the New York company's territory there was again a heavy concentration of trouble on Long Island; the New Jersey company's report

showed ocean-flood damage along the shore and tree damage back from the coast line.

Here, it appeared, added help would be effective, would serve to get service back to more people more quickly.

Bell System companies beyond the storm's range had already been "alerted", so it was no surprise to the Ohio Bell, the Bell of Pennsylvania, and the Chesapeake and Potomac companies to be asked, once the New York-New Jersey situation was comprehended, to lend a hand—300 of them, in fact. The New York company had been able to move some 600 of its own men from other districts to the critical areas too, and some Long Lines crews were able to turn to on local service restoration. They started rolling on Friday, the day after the hurricane, and by the first of the following week some 950* "strangers"—line gangs and splicing crews and installer-repairmen with their own foremen and trucks and tools—were working from dawn to dark side by side with the local men and rapidly ceasing to be strangers.

With such help, the two companies' trouble reports grew less by daily leaps and bounds, and within a week the biggest jobs they have ever had to tackle were well nigh completed, all but exceptional instances of no-service were restored, and the visiting crews were on their way home again with a hearty "So long, fellows!" and "We'll do as much for you some time."

* These figures do not include men shifted by the New England and Southern New England companies within their own territories.

Facts and Figures

For the affected area as a whole—perhaps half the length of the country's entire Atlantic coast line—71 percent of the total number of telephones "out" were back in service again within three days after the storm, 87 percent within six days,

Comparison of the More Important Materials Furnished by Western Electric Company

	Hurricane 1944	*Hurricane 1938*
Lead Covered Cable	864,786 Lin. Ft.	3,944,480 Lin. Ft.
Cable Terminals	3,726	21,735
Drop Wire	16,000,000 Lin. Ft.	56,613,000 Lin. Ft.
Poles	3,936	23,632
Crossarms	6,840	26,900
Copper Line Wire	48,300 Lbs.	1,117,500 Lbs.
Steel Line Wire	107,200 "	1,351,800 "
Strand (suspension)	955,000 Ft.	6,910,000 Ft.
Copper and Steel Sleeves	577,850	2,956,500
Hardware (Pole Line)	434,600 Lbs.	2,039,000 Lbs.
Solder and Lead Sleeving	44,674 "	628,200 "

CABLE SPLICING is a craft which shows to great advantage when one splice may restore many telephones to service

FROM DAWN to dusk the work of restoration progresses

HERE IS another instance of telephone plant which stood up—even though the tree did not

EMERGENCY repairs for government offices, municipal forces, hospitals, and others were made around the clock

"TWISTED PAIR" temporarily bridges a break through the woods

SKILLED MANPOWER, vehicles, supplies, and standardization have their parts in licking a situation like this

and 99 percent within 10. The "all clear" of emergency restoration sounded on the 12th day. The necessary tasks of permanent repair, in some instances the equivalent of new construction, will probably continue in many localities into 1945.

Such statistics as the 12-day figure for the restoration of 414,500 telephones to service last September need some interpretation if they are to be considered in relation to the 28 days required in 1938 to restore 597,000 telephones. The floods and blocked roads which hampered repair crews and slowed up supplies in 1938 were a negligible factor in 1944. Damage by falling trees was less this year—in the sense that where one cable break could and often did put a hundred or more telephones out of order, half a dozen breaks in one cable disabled no more telephones in 1938, but did require just that much longer to fix. Another element was the distribution of damage in the territories of eight Associated Companies this time, as compared with a heavy concentration then of trouble in New England.

The figures on page 193 for the quantities of supplies which Western Electric delivered in 1944 and 1938 sum up the comparison neatly—and demonstrate once again that "stations out of order" alone is not a complete index to the extent of a catastrophe.

The Service of Supply

Basic to restoration of telephone plant is a sufficient supply of equipment and materials, readily available for distribution where it may be needed. That is Western Electric's share in meeting any emergency, big or little: to see that they are on hand when and where they are needed. How well it succeeded in meeting the enormous demands imposed by last September's hurricane is told in part by the same statistics of supply.

They do not tell, of course, of such things as thousands of pounds of supplies carried downstairs by hand under the beams of flashlights when commercial light and power failed the Boston distributing house, nor of the night-and-day operation of the Brooklyn house for 10 consecutive days; neither do they give any picture of the indispensable function of Western's supplies service division at New York headquarters in coördinating the flow of supplies from many sources. Emergency routine is not new to Western people; and the Associated Companies, knowing that repairs are never held up for lack of materials, accept them gratefully and build them swiftly into plant.

How and why this can be so may be demonstrated, for example, by the following incident: On September 18, an 11-car express train loaded with telephone cable, suspension strand, and pole-line hardware left Western Electric's Hawthorne Works in Chicago soon after the New England company's needs had been made known, picked up three more cars at Pittsburgh and one at Kearny, and rolled into the yard of the Boston distributing house just 22 hours after it left Chicago. The running time of the Twentieth Century and the Broadway Limited between Chicago and New York is only five hours less!

There is literally no part of an operating telephone organization which is not affected in some way by so great an emergency as a hurricane. Take

Western Electric Co. supplied more than 160 linear miles of telephone cable to repair damage

Unloading pole-line hardware

A "switcher" backs the "22-hour Chicago-Boston flyer" into Western's Boston house

THESE BELL SYSTEM men, on from Ohio, are all ready to do familiar jobs in strange territory

TRUCKS AND MEN are about to start from Washington for New Jersey and New York

UPSTATE NEW YORK installer-repairmen arrive to give their fellow plant men a hand

as just one instance the credit adjustment which the company voluntarily makes on the bill of each customer whose service is out of order for more than a day or so. The Commercial Department calculates the amount of the credit due in each case, and advises the Accounting Department, in order that the credit for the period of interruption may appear on the customer's next bill.

This is simply standard Bell System practice, of course; but many customers are aware of the extent of hurricane damage to telephone plant and appreciative of the effort to restore service, and insist on paying the bill in full. One customer wrote after last September's storm, for example, that he had had service since 1906, that a hurricane is an act of God for which the telephone company is not responsible, and that he would not accept the credit deduction from his bill.

Ever inspiring is the sense of obligation which brings telephone women to their posts, when due for duty or as volunteers for extra assignment, in the face of gale and torrential rain and possible hazard. Nearly every central office had its numbers of girls who arrived buffeted and drenched. The number was so large at Long Lines switchboards in New York, for example, that matrons' uniforms were given to dozens of them to put on while their own clothes dried. Operators at many central offices were accommodated at nearby hotels on the night of the storm or were put up on lounges and cots in telephone company rest rooms.

Not so easily arranged were quarters for the out-of-town plant men. On Long Island, cots were set up in an armory, for instance, until a summer hotel could be re-opened and put into operation; and on Staten Island the Army provided sleeping quarters in barracks for a hundred men pending the securing of hotel accommodations for them in Manhattan. Both Army and Navy personnel proved cordially coöperative when asked to give an occasional "assist" to the process of getting service back quickly into running order.

Civil authorities also were helpful in many ways. Most obvious, perhaps, was their willingness to make gasoline quickly obtainable for necessary car and truck operations.

And the final word should be devoted to the telephone-using public, surely; the public which constitutes many a statistic in these pages but is, none the less, just the men and women whose patience, whose tolerance, whose understanding, whose cordial encouragement added up, it appeared, to confidence that the Bell System was able to and would accept its responsibility, meet the situation, and carry forward the heavy task of restoration to a prompt and successful conclusion. The Bell System has *earned* that confidence through many years of normal operation and of emergencies met and overcome. Its men and women demonstrated in those days of crisis last September, as in the less trying tasks of day-to-day service, that always they do what is in their power to do to deserve the public's confidence.

Frank Baldwin Jewett: An Appreciation

Robert W. King

On September 30, 1944, being sixty-five years of age, Dr. Frank B. Jewett retired as Vice President of the American Telephone and Telegraph Company and Chairman of the Board of the Bell Telephone Laboratories.

While a young instructor at Massachusetts Institute of Technology, he was attracted by the future of telephone engineering, and in 1904 he joined the research and engineering department of the American Telephone and Telegraph Company, then located in Boston. The loading coil had but recently been introduced, the American Company had purchased the Pupin patents, and the stage was set for energetic prosecution of the possibilities inherent in the new device. The longest open-wire circuit then ran from New York to Chicago and there was no toll cable except a little toll-entrance cable. In this atmosphere Dr. Jewett soon demonstrated his ability to guide and supervise difficult engineering developments and to keep their various phases in step. The tasks that were to come along were of such magnitude and complexity as to give full scope to his outstanding executive talent.

Building upon the loading coil, the New York-Denver line was successfully completed in 1910 and the Boston-Washington underground cable in 1913. These triumphs, however, represented the telephonic limits of loading combined with economic sizes of copper wire. They therefore emphasized the urgent need of a satisfactory repeater.

On the basis of the leadership which he had successfully demonstrated on earlier projects, Dr. Jewett was selected to guide this important quest, and was appointed Assistant Chief Engineer of the Western Electric Company, where he might closely supervise the special repeater studies. The venture was crowned with success, and within three years a practicable basis for transcontinental telephony was at hand in the now familiar vacuum tube which had its genesis in the Edison effect and the deForest audion.

It soon became evident that the vacuum tube had no peer among amplifying devices; in fact, long before completion of the transcontinental line, it was realized that a satisfactory repeater would be the *open sesame* to radio telephony, and the leadership of the scientific group which Dr. Jewett had assembled was again attested by their record-making triumph when, in 1915, they transmitted the voice by radio from Washington, D. C., to Paris and to Honolulu.

The Laboratories under Dr. Jewett now grew rapidly and other practical applications of research followed in quick succession. The vacuum tube, combined with the electric wave filter

invented by Dr. George A. Campbell, realized the old dream of multiplexing both telephone and telegraph channels, first on open-wire lines and then in cables. The Bell System's extensive toll cable project also began to take shape.

As Chief Engineer of the Western Electric Company, then as Vice President, and later as Vice President of the American Telephone and Telegraph Company and President of the then newly-incorporated Bell Telephone Laboratories, Dr. Jewett provided much of the inspiration, leadership, and drive which carried these and many other projects through to completion. Among such, mention must at least be made of developments in the field of dial equipment, in telegraph equipment, and in improved subscriber stations.

Dr. Jewett's foresight and courage were largely responsible for the development of the Bell Telephone Laboratories into the world's leading agency of applied science. Being at heart both a scientist and an engineer, he early appreciated the essential part that coöperative teamwork among considerable groups of technologists must play in the rapid and effective solution of problems as intricate as those frequently to be overcome in engineering. He always preached the philosophy of team-

Frank Baldwin Jewett

work, and was meticulous in his care that credit for achievements went to the team.

In his capacity as leader of the research and development forces of the Bell System, Dr. Jewett's counsels have always played a considerable part in formulating and maintaining the policy of the maximum of economic life which underlies the design of our equipment and the engineering of our telephone plant. His scientific instinct has never been satisfied until he could envisage the best solution of a problem that would be possible in terms of the then available knowledge. After this, and step by step, he would consider such compromises as had to be made to reach a practical solution, but was always reluctant to yield more ground than absolutely necessary.

In propounding his philosophy of industrial research, Dr. Jewett has insisted that the basis of understanding coöperation between the various departments of a large laboratory is something which cannot be created quickly, but must develop slowly over the years with association and with tasks successfully accomplished. Continuity of employment in the technical staffs has therefore been a matter of great insistence with him and one for which he has fought valiantly on occasion.

The soundness of his philosophy has been brilliantly demonstrated by the war achievements of the Laboratories he so long directed. In such vitally important programs as in radar, in underwater warfare, and in fire control mechanisms, the Bell Telephone Laboratories have played an indispensable part; while the host of other projects to which they have contributed is too numerous to mention.

Since its creation by Executive Order in 1940, Dr. Jewett has been a member of the National Defense Research Committee, and has devoted a great deal of his time directly to the scientific problems of the war through that Committee. He has also served as President of the National Academy of Sciences since 1939. This is an assignment which one might say has been surcharged with war responsibilities, for by its charter the Academy undertakes upon request to advise the Federal Government in any matters of a scientific nature.

So, upon his retirement from the telephone organization, Dr. Jewett goes forth to spend his full time on war assignments. No one hopes more than he does that these will soon pass out of existence, but until they do his long telephone record attests that the job will receive the unstinted effort of a tireless body and a tireless mind.

The Frank B. Jewett Fellowships

Establishment of a trust fund by the A. T. & T. Company to finance post-doctorate fellowships in physical science in honor of Dr. Frank B. Jewett was announced on September 22.

Five fellowships will be awarded annually. Their purpose is to stimulate and assist research in the fundamental physical sciences, and particularly to provide the holders with opportunities for individual growth and development as creative scientists. The fellowships provide an annual honorarium of $3,000 to the holder and $1,500 to the institution at which the recipient elects to do research.

The Frank B. Jewett Fellowships will enable their recipients to devote

themselves to research in pure science for a year or two following their doctorates. Since a purpose of the fellowships is to provide for the full-time continuation of academic research, awards will normally be made to those who have obtained the doctorate within the preceding year, or are expected to receive that degree not later than the beginning of the next fellowship term which starts each July first.

The fellowships will be awarded on recommendation of the Frank B. Jewett Fellowship Committee. This committee will consist of seven members of the scientific staff of Bell Telephone Laboratories who are actively and creatively engaged in research in the respective fields of physics, mathematics, and chemistry.

In the selection for fellowship awards the primary criteria will be: demonstrated research ability of the applicant, the fundamental importance of the problem he proposes to attack, and the likelihood of his growth as a scientist.

William P. Banning Retires

William P. Banning, assistant vice president of the A. T. & T. Company, was retired at his own request on October 31.

For more than 20 of his 24 years in the Information Department, Mr. Banning was intimately associated with this Magazine and its predecessor, the Bell Telephone Quarterly, of which Vol. I *No. 1* appeared in 1922. During two decades of the Bell System's most rapid growth in size and in service, he helped to shape the publication's policies, arranged for the many contributions which appeared between its covers, and guided the gradual development which brought it to increasing usefulness.

Mr. Banning seldom made use of the title of "Editor," for to him the Magazine was but one of the several media through which he

William Peck Banning

undertook to make apparent to both telephone people and the public the facts, the aims, and the policies of the Bell System.

He looked upon work in the telephone business not as a job, but as a profession, a service of a high degree of usefulness rendered to the public on a high plane and, therefore, a profession of great possibilities of satisfaction to those who worked in it. In spreading this philosophy he has rendered a service to the public and to employees of the Bell System.

For the Record

A selected list of happenings, of System interest, occurring between August 1 and October 31, 1944

RATE REDUCTIONS on telephone calls to seven Caribbean countries became effective on September 1. The reductions apply on calls to Costa Rica, Guatamala, Honduras, Nicaragua, Panama, Curaçao, and Surinam.

Message toll telephone service was opened on October 15 between the U. S. and Anchorage, Alaska.

It was announced on October 25 that rates for radio telephone calls to Hawaii, Jamaica, and the Bahama Islands were to be reduced generally, effective November 1.

Establishment of a trust fund by the A. T. & T. Company to finance five post-doctorate fellowships in physical science, in honor of Vice President Frank B. Jewett, was announced on September 21. Dr. Jewett retired from the Bell System on September 30.

On October 18, L. A. Wilson, assistant vice president in charge of the commercial division of the O. & E. Department of the A. T. & T. Company, was elected a vice president of the company, to be in charge of business research and studies of Bell System revenue requirements.

Walter S. Gifford, President of the American Telephone and Telegraph Company, delivered an address before the United States Independent Telephone Association at its annual convention in Chicago on October 11. This is the first time the Association has been addressed by a President of the American company.

The World's Telephones in War-time

Knud Fick

TOTAL WAR is war of production as well as of destruction, and the enormous productive effort achieved under stress of war by the United States would certainly have been impossible without the aid of rapid, dependable, and universal telephone service. In the last two years alone, between Pearl Harbor and the end of 1943, this country has added nearly three million telephones and two and a half million miles of telephone wire to its telephone facilities, while the total number of Long Lines conversations increased about 75 percent.

As regards the world outside the United States, the situation is less clear, largely due to the dearth of adequate statistical information. The table on the following pages, however, embodies the latest available data, gathered from a variety of sources, and indicates world totals of nearly 50 million telephones and 200 million miles of telephone wire, carrying altogether over 70 billion completed messages per year. Where countries are represented in this compilation by statistics for earlier years, no information is available as to possible expansion of telephone facilities there during the war years; neither are data available as to the extent to which existing telephone plant and manufacturing facilities have been destroyed; so that the world totals shown should be accepted as an indication of existing conditions rather than as a factual statement.

AS IN THE PAST, the telephone leadership of the world is firmly maintained by the United States, with more than half of the world's telephones and telephone wire. The more than 26 million telephones in this country correspond in number to 19.3 percent of the total population, as against 2.8 percent in Europe and an average of 0.4 percent for the rest of the world. The telephone wire in this country, similarly, amounts to four-fifths of a mile per person, or over 7 times more than in Europe and 46 times more than in the rest of the world in relation to population.

New York, with close to two million telephones, is still the leading city in the world, telephonically speaking. Next in telephonic size come the Chicago and London telephone areas, each with more than one million telephones. With more than 44 telephones per 100 inhabitants, San Francisco has the highest telephone development of any large city, closely followed by Stockholm, Sweden, with 43.5, and Washington, D. C., with 39.5, telephones for every 100 inhabitants. The average telephone development of cities in this country is about twice as high as for cities in the rest of the world.

(*Statistics on pages 206–207*)

LATEST AVAILABLE TELEPHONE STATISTICS OF THE WORLD (PARTLY ESTIMATED)

Countries	Date of Statistics	Telephones		Wire		Conversations		Telephones in Large Cities		
		Number	Per 100 Pop.	Thousands of Miles	Per 100 Pop.	Millions	Per Aver. Cap.	Exchange Area	Telephones	Per 100 Pop.
NORTH AMERICA:										
United States	Jan. 1, 1944	26,381,000	19.3*	108,000	79.1*	35,080	258.4*	New York City†	1,889,181	27.2
Canada	" 1, 1943	1,627,775	14.0	6,015	51.6	2,999	258.4	Montreal	222,056	19.6
Central America	" 1, 1942	36,797	0.4	63	0.7	—	—	—	—	—
Mexico	" 1, 1944	200,000	0.9	900	4.2	800	38.0	Mexico City	110,000	7.1
West Indies—										
Cuba	" 1, 1944	78,000	1.8	360	8.4	420	98.2	Havana	55,000	7.6
Puerto Rico	" 1, 1944	23,272	1.2	46	2.4	50	26.3	San Juan	12,000	6.9
Other W. Indies	" 1, 1942	36,064	0.4	124	1.5	—	—	—	—	—
Other N. America	" 1, 1942	25,000	6.2	28	7.0	—	—	—	—	—
Total	—	28,407,908	14.7	115,536	59.8	39,450	205.5	—	—	—
SOUTH AMERICA:										
Argentina	Jan. 1, 1942	511,880	3.8	1,862	13.8	2,178	162.4	Buenos Aires	310,002	9.0
Bolivia	" 1, 1942	2,680	0.1	6	0.2	—	—	La Paz	1,142	0.6
Brazil	" 1, 1943	331,000	0.8	1,360	3.2	1,700	40.3	Rio de Janeiro	131,384	6.6
Chile	" 1, 1942	96,641	1.9	345	6.8	300	59.3	Santiago	51,743	5.4
Colombia	" 1, 1942	43,717	0.5	200	2.2	200	21.5	Bogota	16,000	4.3
Ecuador	" 1, 1942	8,000	0.3	10	0.3	—	—	Quito	3,563	2.4
Paraguay	" 1, 1942	3,881	0.4	9	0.8	17	16.5	Asuncion	3,339	3.0
Peru	" 1, 1942	36,344	0.5	137	1.9	145	20.6	Lima	24,856	4.7
Uruguay	" 1, 1942	57,822	2.7	187	8.6	160	73.5	Montevideo	42,103	5.9
Venezuela	" 1, 1942	36,138	1.0	120	3.3	214	58.6	Caracas	25,763	8.1
Other S. America	" 1, 1942	3,552	0.6	9	1.6	—	—	—	—	—
Total	—	1,131,655	1.2	4,245	4.7	4,930	54.4	—	—	—
EUROPE:										
Belgium	Jan. 1, 1940	428,752	5.1	2,200	26.2	325	38.7	Brussels (II/28–1938)	127,639	12.9
Bulgaria	" 1, 1943	35,947	0.4	100	1.2	80	9.4	Sofia (I/1–1940)	11,686	3.3
Czechoslovakia	" 1, 1938	215,853	1.4	700	4.6	300	19.7	Prague	74,586	7.7
Denmark	Mar. 31, 1943	511,622	13.1	1,700	43.6	825	212.1	Copenhagen (I/1–1941)	223,817	24.3
Eire	" 31, 1943	49,269	1.7	160	5.4	44	14.9	Dublin	27,393	5.6
Finland	Jan. 1, 1941	186,548	5.1	330	9.0	318	86.4	Helsinki	58,508	23.4
France	" 1, 1940	1,622,680	3.9	6,230	14.8	852	20.3	Paris (I/1–1939)	437,139	15.5
Germany	June 30, 1939	4,226,504	5.3	18,500	23.0	3,700	46.2	Berlin (III/31–1939)	599,911	13.8
Gt. Britain & N. Ireland	Mar. 31, 1943	3,575,000	7.5	18,000	37.5	2,500	52.1	London	1,100,000	12.2
Greece	Jan. 1, 1940	54,404	0.8	188	2.6	130	18.4	Athens	28,029	5.5
Hungary	" 1, 1943	244,934	1.7	570	3.8	320	21.6	Budapest (I/1–1939)	107,906	6.6

Italy	" 1, 1941	685,815	1.6	1,800	4.1	1,300	29.5	Rome (I/1–1939)	122,442	9.6
Netherlands	" 1, 1942	498,223	5.5	1,600	17.8	540	60.3	Amsterdam (I/1–1939)	67,927	8.6
Norway	June 30, 1940	255,712	8.7	780	26.5	300	102.1	Oslo (VI/30–1939)	73,786	17.7
Poland	Mar. 31, 1939	294,828	0.8	1,068	3.0	621	17.8	Warsaw	90,627	7.0
Portugal	Jan. 1, 1943	86,512	1.1	210	2.7	139	17.8	Lisbon (I/1–1942)	37,701	5.3
Romania	" 1, 1943	102,742	0.6	430	2.5	230	13.5	Bucharest (I/1–1940)	50,347	5.5
Russia (U.S.S.R., incl. Siberia)	" 1, 1939	1,272,500	0.8	2,000	1.2	—	—	Moscow (I/1–1936)	144,669	3.5
Spain	" 1, 1944	393,000	1.5	2,100	7.7	870	32.2	Madrid (I/1–1942)	76,564	7.0
Sweden	" 1, 1943	1,034,000	16.0	3,900	60.4	1,400	217.7	Stockholm (I/1–1942)	200,733	43.5
Switzerland	" 1, 1944	567,517	13.2	1,950	45.4	434	101.3	Zurich (I/1–1943)	84,933	24.3
Yugoslavia	" 1, 1940	72,000	0.5	172	1.1	300	19.1	Belgrad (I/1–1939)	15,218	4.8
Other Europe	" 1, 1942	214,706	1.1	735	3.7	—	—	—	—	—
Total	—	16,629,068	2.8	65,423	11.0	17,100	28.9	—	—	—
ASIA:										
British India	Mar. 31, 1939	83,378	0.02	460	0.1	—	—	Calcutta (III/31–1941)	24,048	1.5
China	Jan. 1, 1941	160,000	0.04	600	0.1	—	—	Shanghai (IX/30–1941)	93,559	2.3
Japan	Mar. 31, 1939	1,367,958	1.9	4,864	6.7	5,339	74.2	Tokio	290,510	4.5
Other Asia	Jan. 1, 1942	333,074	0.2	1,040	0.5	—	—	—	—	—
Total	—	1,944,410	0.2	6,964	0.7	8,000	7.5	—	—	—
AFRICA:										
Egypt	Jan. 1, 1940	67,983	0.3	397	1.8	214	9.6	Cairo	29,164	2.1
Union of S. Africa	Mar. 31, 1941	235,686	2.2	1,000	9.5	320	30.7	Johannesburg	63,881	10.5
Other Africa	Jan. 1, 1942	153,751	0.1	460	0.3	—	—	—	—	—
Total	—	457,420	0 3	1.857	1.1	730	4.4	—	—	—
OCEANIA:										
Australia	June 30, 1943	766,846	10.6	3,550	49.1	687	95.4	Sydney (I/1–1942)	188,018	14.2
Hawaii	Jan. 1, 1944	67,602	12.8	186	35.1	150	291.3	Honolulu (I/1–1942)	34,014	17.0
Netherlands E. Indies	" 1, 1941	56,377	0.1	280	0.4	84	1.2	Batavia (I/1–1940)	12,356	1.8
New Zealand	Mar. 31, 1943	238,441	14.6	700	42.8	600	367.2	Auckland (III/31–1942)	35.743	16.6
Philippine Islands	Nov. 1, 1941	36,890	0.2	88	0.5	170	9.7	Manila	28,144	3.5
Other Oceania	Jan. 1, 1942	5,897	0.2	14	0.6	—	—	—	—	—
Total	—	1,172,053	1.2	4,818	4.8	1,700	17.1	—	—	—
TOTAL WORLD	—	49,742,514	2.3	198,843	9.0	71,910	32.7	—	—	—

NOTES: The above statistics incorporate the most recent information available on August 1, 1944. The total number of telephone conversations for each continent and for the world as a whole include estimates in respect of countries for which no accurate data are available.

* Based on total United States population, including military forces at home and abroad.

† The telephone development of other representative cities in the United States was, on January 1, 1944:

Chicago, Ill.	1,151,704	telephones,	or	34.2	per	100	population	Milwaukee, Wis.	205,686	telephones,	or	27.3 per 100 population
Los Angeles, Cal.	559,264	"	"	32.9	"	"	"	Minneapolis, Minn.	191,872	"	"	36.7 " " "
Washington, D. C.	364,204	"	"	39.5	"	"	"	Seattle, Wash.	183,943	"	"	33.6 " " "
Cleveland, Ohio	362,051	"	"	31.5	"	"	"	Denver, Col.	129,296	"	"	36.4 " " "
San Francisco, Cal.	332,428	"	"	44.1	"	"	"	Hartford, Conn.	88,076	"	"	32.7 " " "
Boston, Mass.	217,367	"	"	32.0	"	"	"	Omaha, Neb.	80,380	"	"	31.0 " " "

Robert W. King

Knud Fick

(*Continued from page 135*)

He has contributed several articles to this MAGAZINE, the most recent, in the issue for Spring, 1944, being "A Bridge for Speech across Chesapeake Bay."

IT IS certainly to be hoped that conditions will not continue to arise which would make writing about hurricanes a habit with JUDSON BRADLEY. His story of the telephone destruction and reconstruction after the New England hurricane of six years ago, "The Bell System Meets Its Greatest Test," appeared in the BELL TELEPHONE QUARTERLY for October, 1938. To write it, he visited all the New England States save Maine; but he was able to see only part of Cape Cod after last September's blow. He joined the Publicity Department of the Southern New England Telephone Company in 1925, after several years of editorial experience elsewhere, and since 1930 has been a member of the staff of the A. T. & T. Company's Information Department.

TECHNICAL and scientific publications—the *Bell Laboratories Record* and the *Bell System Technical Journal,* for instance—can appropriately appraise at length the contributions of Dr. Frank B. Jewett to the art of electrical communication and his influence upon the development of research in applied science. No more than a few pages must suffice here to mark his retirement, and ROBERT W. KING has made a point of being entirely objective about the withdrawal of the superior officer with whom he has been closely associated in recent years. In a career in science which has served the Bell System since 1917, Dr. King has been—among other things—assistant technical director in Europe for the A. T. & T. Company from 1929 to 1935, and, since 1940, assistant vice president of that company's Department of Development and Research. With Dr. Jewett's retirement, he has become Assistant to the President of the Bell Telephone Laboratories.

THAT the statistics on pages 205–207 necessarily include many an estimate which conforms with the cynic's definition of "an educated guess," their compiler, KNUD FICK, would doubtless freely admit. They are, nonetheless, the best obtainable, and are published here as a matter of record. Mr. Fick was born in Denmark, and served in the Danish Foreign Office and other branches of the Danish government until he joined the A. T. & T. Company in 1925. In the chief statistician's division of the Comptroller's Department he is in charge of statistics and economics relating to foreign telephone development. The present is his ninth contribution to the MAGAZINE and its predecessor on this topic.

ume XXIII • Number Four Winter 1944-45

Bell Telephone MAGAZINE

More and Better Telephone Service for Farmers • JOHN J. HANSELMAN AND HAROLD S. OSBORNE

Bell Laboratories in the War • OLIVER E. BUCKLEY

Building the West's New Telephone Route • RICHARD C. SMITH

FM Program Transmission: A Bell System Service

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Western Electric's First 75 Years: A Chronology • FRANK H. LOVETTE

merican Telephone & Telegraph Company • New York

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Winter 1944-45

More and Better Telephone Service for Farmers, *John J. Hanselman* and *Harold S. Osborne*, 213

Bell Laboratories in the War, *Oliver E. Buckley*, 227

Building the West's New Telephone Route, *Richard C. Smith*, 241

FM Program Transmission: A Bell System Service, 255

Providing Paths for Long Distance Calls, *Ralph I. Mabbs*, 263

Western Electric's First 75 Years: A Chronology, *Frank H. Lovette*, 271

For the Record, 288

"The ideal and aim of the American Telephone and Telegraph Company and its Associated Companies is a telephone service for the nation, free, so far as humanly possible, from imperfections, errors, or delays, and enabling anyone anywhere to pick up a telephone and talk to anyone else anywhere else, clearly, quickly and at a reasonable cost."

A Medium of Suggestion & a Record of Progress

Published for the supervisory forces of the Bell System by the Information Department of American Telephone and Telegraph Co., *195 Broadway, New York 7, N. Y.*
Walter S. Gifford, *President;* Robert H. Strahan, *Secretary;* Donald R. Belcher, *Treasurer*

Who's Who & What's What *in This Issue*

LAID END TO END, a hundred million dollars will reach a long way out many a country road and across many a rural acre to extend telephone service to the million farms where the Bell System will seek new customers after the war. The constructive program which so large a sum will be spent to accomplish is described by JOHN J. HANSELMAN and HAROLD S. OSBORNE —who view it with a nation-wide perspective. For Mr. Hanselman is assistant vice president heading the Commercial Division, and Mr. Osborne is chief engineer, of the Department of Operation and Engineering of the A. T. & T. Co. Mr. Hanselman's Bell System career began in 1921, when he entered the rate section of the O. & E.'s Commercial Division as an engineer. The intervening years have seen him as group head in several sections of the Division, sales engineer, rate engineer, and in his present post since late last year. Mr. Osborne joined the A. T. & T Co. in 1910 as an engineer in the then transmission and protection department, and has since been transmission engineer, operating results engineer, plant engineer, and assistant chief engineer. He became chief engineer in 1943. He is the author of more than a score of published scientific and engineering papers, is a past president of the A.I.E.E., and is a fellow of a number of engineering societies.

WHAT PART are the scientists and engineers of Bell Telephone Laboratories playing in this global war? The Army and the Navy know the answers to that question, but the public has had little opportunity to know or learn about the Laboratories' activities. OLIVER E. BUCKLEY, president of the Laboratories, can talk about Laboratories' accomplishments in only the most general terms at present; but as an interim report, pending war's end, his contribution to this issue will make every System man and woman proud of the ways in which the Laboratories is hastening victory. Dr. Buckley entered the Bell System in 1914 as a research physicist; became assistant director of research of the Laboratories in 1927, and director in 1933; was

John J. Hanselman

Harold S. Osborne

Oliver E. Buckley

Richard C. Smith

Ralph I. Mabbs

Frank H. Lovette

made executive vice president in 1936; and was elected president in 1940. During the previous war he had charge of the U. S. Signal Corps laboratory in Paris, with the rank of Major. He is a fellow of several scientific and engineering societies, and a member of the National Academy of Sciences and the American Philosophical Society. He has recently been appointed to the National Inventors' Council and the Research Board for National Security.

THE ACCOUNT of the construction of the DBR line in this issue is the first to be published concerning this remarkable and interesting project. Even though the big job was completed more than two years ago, mention of it has been restricted until now, for reasons of national security. RICHARD C. SMITH gathered his information through interviews with the men who engineered and built the DBR, and his article represents a cross-section of their personal experiences and observations. Before joining the Pacific Telephone and Telegraph Company as a commercial student in 1924, Mr. Smith served in the Army in the last war, and worked on California newspapers. Since his employment with the company, he has been engaged for the most part in advertising, publicity, and magazine writing. He was appointed supervisor of the news bureau in 1939, and editor of *Pacific Telephone Magazine* in 1944.

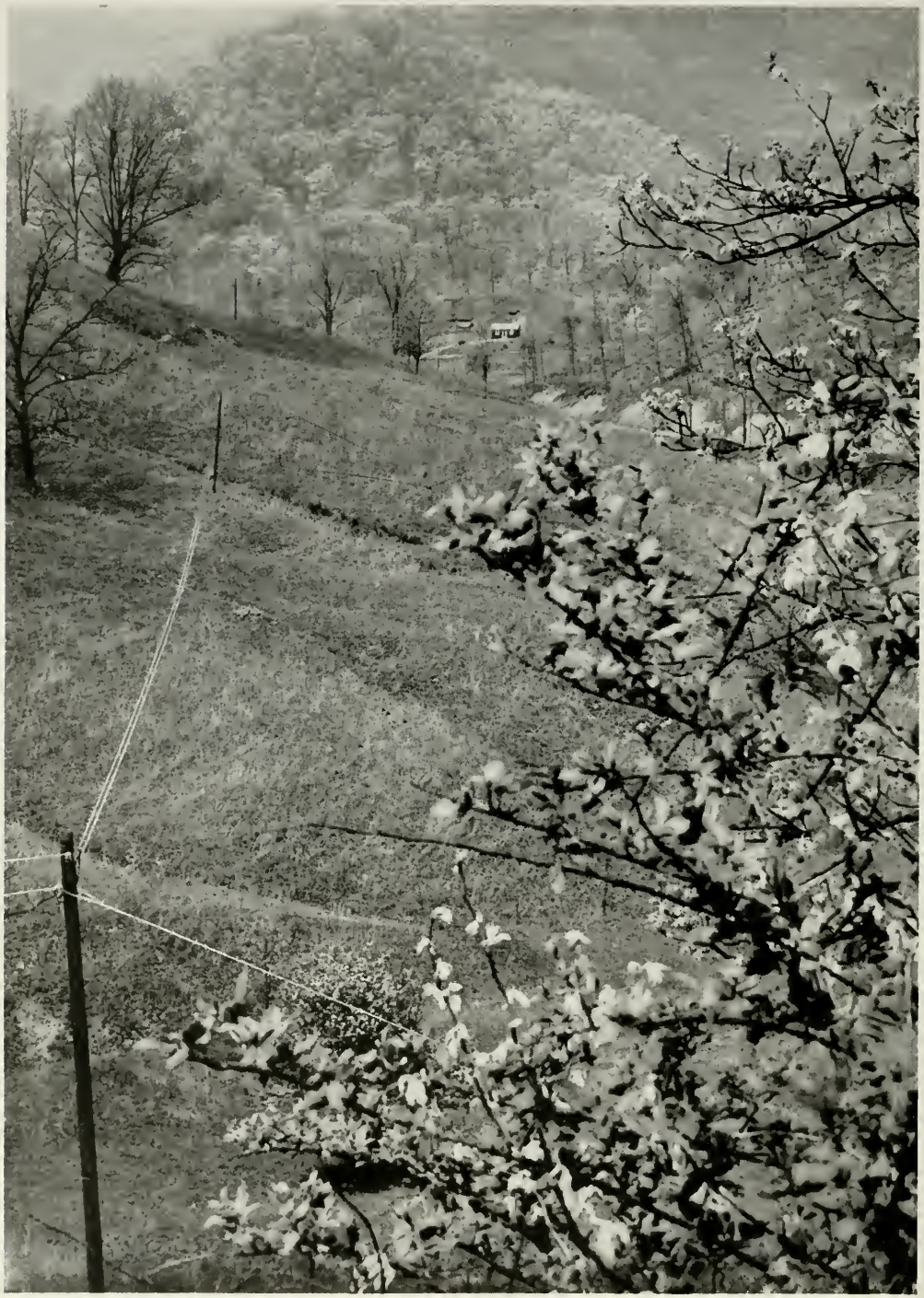
WHAT ARE the Bell System's facilities for transmitting FM (frequency modulation) radio programs? And what is frequency modulation, anyway? These two questions are of interest to many people, including telephone people, and the answers to them are the subject-matter of the article which will be found on later pages. So many hands were involved in making light work of a technical subject which may easily be heavy going that the author can be listed only as that well-known and prolific writer, ANONYMOUS.

THERE'S MORE to a long distance circuit than a pole and a wire. To plan the path of a long distance call from the calling to

(*Continued on page 288*)

Index to Volume XXIII

AN INDEX to Volume XXXIII (1944) of the BELL TELEPHONE MAGAZINE may be obtained upon request to the Information Department of the American Telephone and Telegraph Company, 195 Broadway, New York 7, New York.



Over the hill on private right of way strides this long-span high-strength steel wire telephone line to the farmhouse in the valley. See the article beginning on the opposite page

The Bell System Plans to Provide Service to Another Million Farms as Quickly as Men and Materials Become Available to Carry Out Its Extensive Program

More and Better Telephone Service for Farmers

John J. Hanselman and Harold S. Osborne

THE BELL SYSTEM has plans for extending telephone service to another million rural homes within three to five years after men and materials are again available. This program, which will cost about $100,000,000, calls for adding as telephone customers half the farms in Bell territory not now having service. When this objective is attained, there will remain for future telephone development in Bell System territory less than one-third of the farms. And the program contemplates continuing and accelerating the modernization of the farmer's telephone equipment and improving the quality of his service.

While this is obviously a tremendous undertaking, it is primarily a continuation and an expansion of a rural program which had been actively under way for a number of years until the war cut down its pace. Since 1940, in the country as a whole, telephone service has been installed on nearly 400,000 additional farms; since the bottom of the depression, in the mid-1930's, the additional farm telephones amount to more than 500,000.

The United States leads the world in telephone development—and this is true not only with respect to telephone development in the larger towns and cities but also in the smaller rural communities.

That is the foundation on which the System's program is built—and from which it marches forward.

The steps by which this far-reaching expansion of rural service will be brought about—and some of them are under way now on a test basis in various parts of the country—are

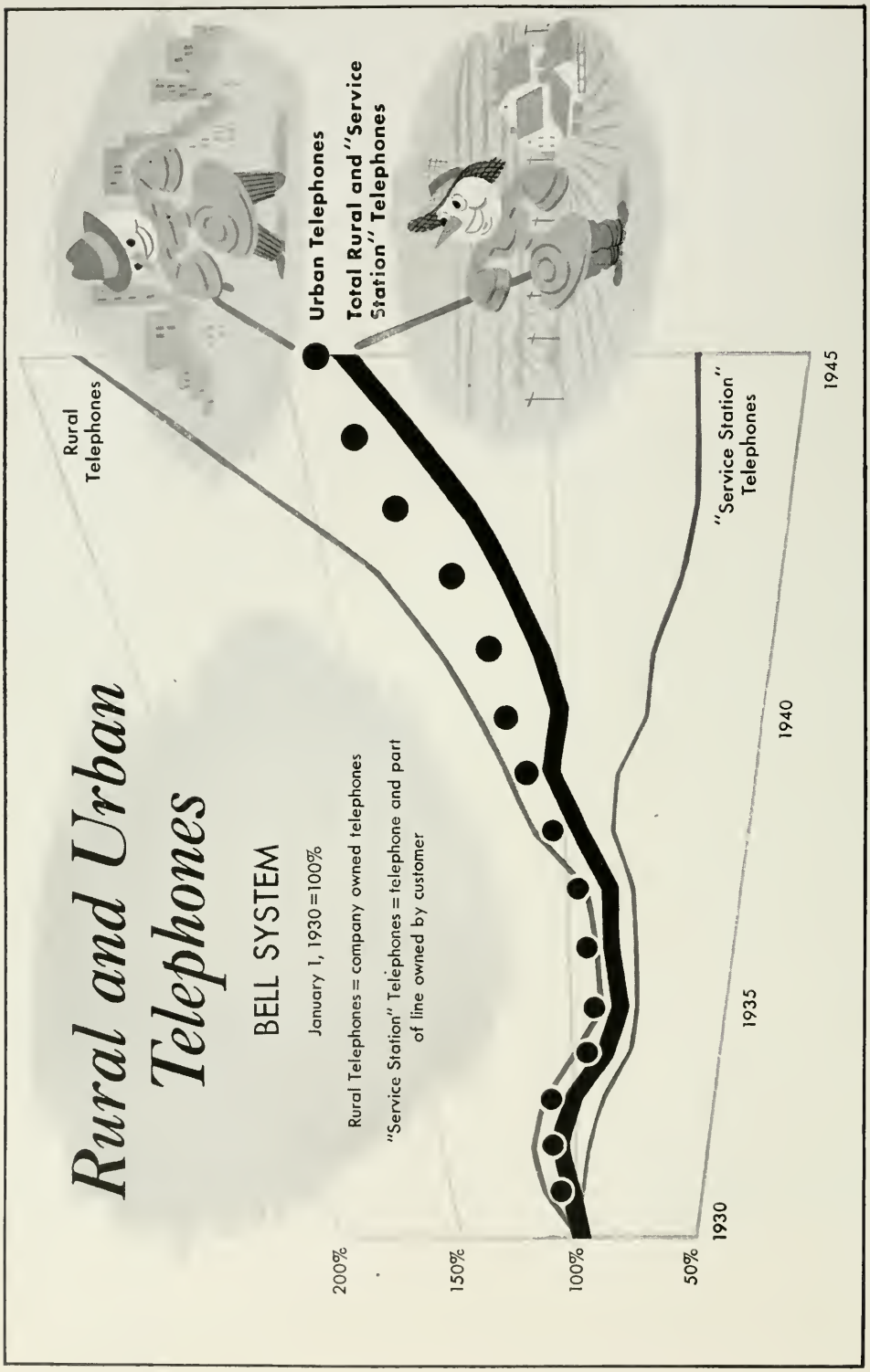


CHART I, showing the substantial growth of telephones in rural areas

already well defined. They include, in brief summation:—

1. Finding out the particular features of telephone service desired by present and potential customers in rural territory;

2. Laying plans for extending facilities to areas not now reached, using latest economical methods of construction;

3. Setting up specific plans for improving service and modernizing facilities; and,

4. As these steps are accomplished, making sure that people without telephone service understand both its availability and its many advantages—in increasing the efficiency and profit of farm operations, in bringing help in time of need, and as a means of keeping in touch with friends and relatives.

MOREOVER, the independent telephone industry is understood to have plans for extending telephone service in farming and "country" areas which in the over-all run parallel to the Bell System program. Speaking by nvitation at the annual meeting of the U. S. Independent Telephone Association last autumn, President Walter S. Gifford of the A. T. & T. Co. said in part:

"The point is that it [rural telephone service] is not developed as far as we in the industry would like to have it. As a post-war objective, I suggest that the entire industry unite on the problem of finding ways and means to furnish satisfactory telephone service for the farmer at a cost that more of them can afford. Fortunately, there are developments in sight that make it look as if this could be done."

Since that time, a committee of experienced operating men has been appointed from among members of the independent telephone industry to attack the problems of rural service on behalf of the Association.

It is thus apparent that the problems—and they are real and many—of extending and bettering service to the country's farms and rural enterprises are being approached by the telephone industry on a broad and realistic basis.

The Economics of Farm Service

THERE ARE many evidences that the proportion of farms with telephones is related to, and indeed is substantially affected by, the economic welfare of the farming and rural population.

In terms of monthly rates, telephone service is one of the least expensive conveniences which farmers can enjoy: the equivalent in outlay, for example, of not more than two or three gallons of gasoline a week and often less. Rates for *rural* service (where the company provides all the facilities as well as the service) have, on the whole, decreased somewhat during the last 15 years. Rates for *service-station* service (for which a mutual association or coöperative group provides the telephone instruments and part of the line) have remained relatively stable at a nominal charge. In connection with this latter service, the telephone company provides the line from the edge of town to the central office, as well as the switching service. The rates for both types of service vary from place to place, of course, in consonance with varying conditions.

The trends in rural, urban, and "service station" telephones during the last 15 years are shown on Chart I on the opposite page.

Company-owned rural telephones

in the Bell System have increased steadily since their low point in the 'thirties and, significantly, at a faster rate than urban telephones.

Service-station telephones, on the other hand, have decreased somewhat. The decrease may not all represent a loss in farm telephone service, however; for there have been numerous instances of farmers who have wanted to be relieved of the responsibility of maintaining a satisfactory grade of service and have asked the Bell company to buy, maintain, and operate the service line as a company-owned rural line. Also, consolidation of farms and farm homes, and other consequences of economic stress, have probably had a part in lessening the number of service-station telephones in use. But despite their decrease in recent years, service-station lines will undoubtedly continue to have an important place in serving much of the remaining territory. This includes the more sparsely settled sections, where a group of farmers find it more economical to build their own pole line; the marginal farm areas, where the low service-station rate is particularly attractive; and also those situations

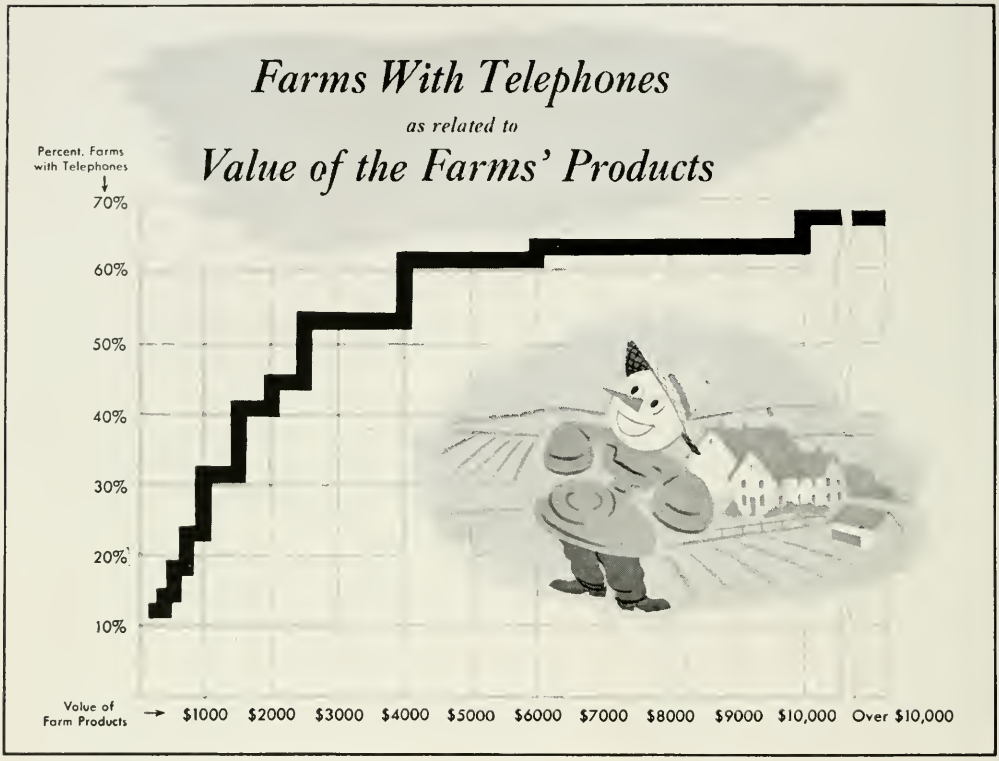


CHART II, illustrating how the proportion of farms with telephones increases with the economic welfare of the farmer

where farmers, because of their other coöperative activities, prefer service from a mutual group or coöperative organization.

Although service-station telephones are fewer, the total of these and company-owned rural telephones combined shows an increase which tops by a substantial margin the previous high point of 1931. It makes an interesting comparison to note that the two combined have increased since the depression at almost as fast a rate as have urban telephones. Herein lies further indication of the continuing attention which has been devoted to the extension of telephone service among the farming population.

THERE IS a considerable variation in the rural telephone development in different parts of the country. Indications are that these differences are primarily due to differences in the economic welfare of the farmer rather than to rate levels or other telephone factors. For example, in two states having for many years about the same levels of telephone rates, the percentage of farms with telephones is more than 40 in one case and about 15 in the other. The average value of farm products per farm in the former state is approximately $1,500, and in the latter it is about $700.

The relationship between farm prosperity and farm telephones is illustrated again by Chart II, which shows how the percentage of farms with telephones increases in proportion to the value of the farms' products. The chart is based on data from the U. S. Census of 1940, which also indicates that nearly one-fifth of the nation's farms have farm products of an annual value of less than $250, and that almost another ten percent, principally in the South, are farmed by share-croppers also having a very low average annual value of products. It can be demonstrated, county by county across the nation, that when and where farmers are receiving reasonably good prices, there the percentage of farms with telephones has been high—and that the converse is also true.

It is evident, therefore, that while the telephone industry feels it can increase substantially the telephone development on farms, the problem has been and is more difficult in areas where the economic status of the farmer is less satisfactory.

Means for Providing Service for More Rural Customers

ALONG WITH its market analyses, and its highway-and-byway surveys of facilities for present and prospective telephone users, the Bell System is searching intensively for means whereby telephone costs as well as telephone lines may be brought within the reach of more rural homes.

Estimates indicate that about two-thirds of all rural homes lie along existing telephone pole lines. Since one-third of all rural families have telephone service, this means that approximately half of the families along existing pole lines now have telephones. It is estimated, moreover, that 80 percent of all rural families are located either along existing pole lines or near enough to them so that service can be carried to them without a special construction charge.

The challenge which the rural problem presents to the nation's telephone industry is, therefore, two-fold. It consists not alone of extending facilities to the 20 percent of farm families not now close to existing telephone pole lines: it includes also the need for making the advantages of telephone service more fully understood by the families within easy reach of lines now in place; and, as an important part of this last, for improving the service furnished to rural telephone users.

A "SERVICE STATION" telephone line using ordinary steel wire, serving a fruit growing region

Although war needs for men and materials now restrict the extension and betterment of plant, many extensions of rural lines to serve farmers are being made under present WPB regulations, which give preferred status to producers of substantial quantities of food. In building these extensions, advantage is taken of the development of methods for using high-strength steel wire. This permits "long span" construction, with distances of from 350 to 450 feet between poles, instead of the former 150 to 200 feet, and reduces by nearly half the cost of building rural lines. The part which this type of economical construction can play in extending pole lines, after the war, is apparent.

Further economies in the future are also expected through the increased use of mechanical devices such as pole-hole diggers, and through other improvements in construction methods.

PRIOR TO the war, a new type of rubber covered wire for rural telephone service, which could be buried directly in the ground, had been developed by Bell Telephone Laboratories, and with it a plow which, drawn through the earth by a truck, deposits the wire two feet below the surface in a single operation. This wire has already proved itself useful in some kinds of soil, and after the war its use is expected to be extended through improvements in its construction.

Another possibility, of a different sort, lies in the installation of very small dial switching units near groups of farms, giving the farmers and their families more direct communication among each other and reducing the

amount of line wire required to connect them to their telephone exchange. The post-war outlook for increasing the usefulness of this arrangement is already being investigated.

A MOST interesting development, actively under way until war requirements took precedence, is a means for taking telephone service to farms which are remote from existing telephone pole lines but are situated along electric power lines. This development is known as "power-line carrier," and involves using electric power wires simultaneously for power service and for telephone service. It applies to this use a technique perfected over many years by the Bell System to make possible the transmission of many telephone conversations over the same pair of conductors simultaneously without interference. This is accomplished by the use of high-frequency currents which are commonly said to "carry" the telephone conversation.

As applied to "power-line carrier," this means, in non-technical terms, that a high-frequency telephone current, carrying conversation, can "hitch-hike" a ride along an electric power line, hop off the power line at an appointed spot and onto a pair of telephone wires running into the customer's premises, and thus reach the telephone, over which conversation takes place in no way different—to the speaker—from normal telephone usage.

Electronic apparatus which creates the high-frequency current and, when a person is speaking into the telephone, varies or "modulates" it in such a way that it can carry the conversation, is installed in or near the central office and on the customer's premises. The high-frequency telephone currents hop on and off the power line by means of "carrier couplers" installed on the power-line pole. These couplers do not permit the power current to pass; but the telephone carrier currents, being of very high frequencies, can pass over the power line simultaneously with the power currents, without any mutual interference, whereas this could not be done if ordinary telephone currents were used.

SPANS averaging from 350 to 450 feet, using high-strength steel wire, materially reduce construction costs

SUCH A PLOW, pulled by a truck, buries rubber-insulated telephone wire in the ground in a single economical operation

To accomplish all this, the equipment at the subscriber's premises will probably appear like a small table-model radio, including vacuum tubes, and with it will be associated a telephone. It must be provided with power from an ordinary electric outlet and must be energized continuously so that it will be able to receive telephone calls at all times. The apparatus at the central-office end will be similar but slightly more complicated. The layout of a power line carrier system is illustrated on pages 222 and 223.

To the operator at the switchboard, a power-line carrier circuit will appear no different from a wire circuit. Power-line carriers will give the same types of service as the present wire circuits. The subscriber will receive rings in the same way as over wire circuits, and will make calls to the operator in the same way as subscribers on common-battery wire lines, simply by lifting the telephone from its cradle.

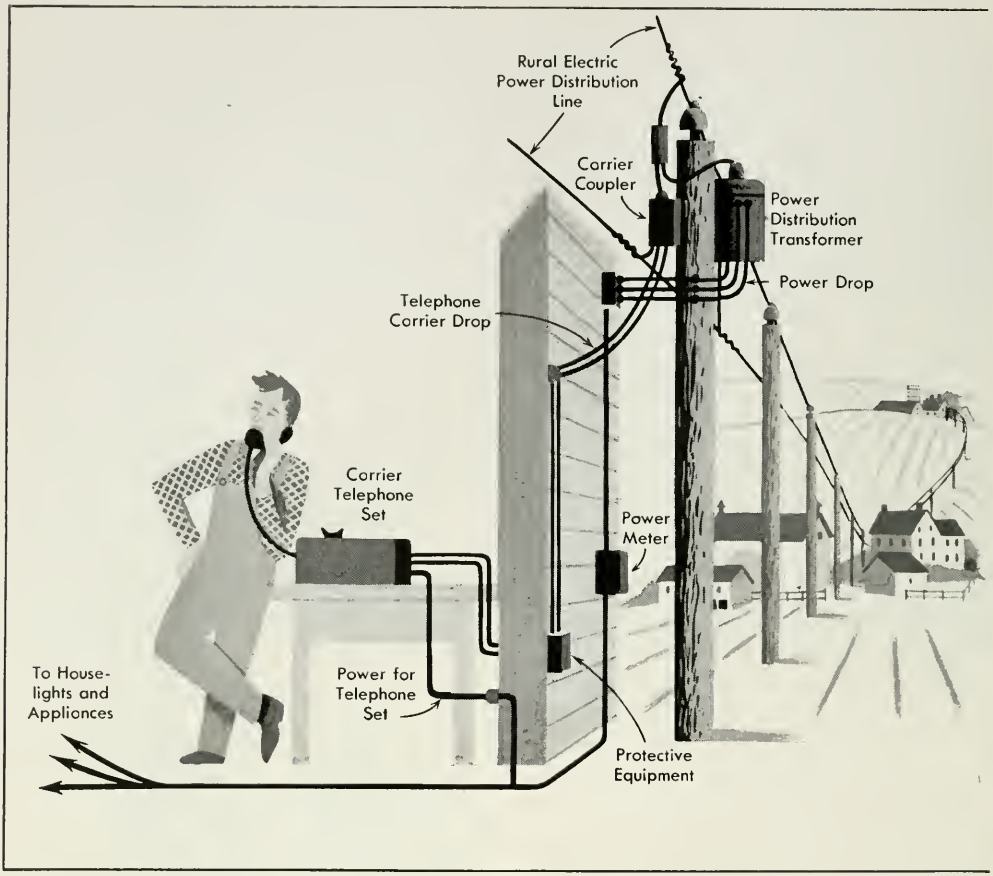
While power-line carrier development is not completed, present indications are that it will be useful in extending telephone service to many of the 20 percent of the farms in Bell territory which are not near existing telephone lines.

Bell Telephone Laboratories and the System companies are coöperating with both the Rural Electrification Administration and private power companies in working out the application of this system. As soon as war conditions permit, the Laboratories will complete its development and

make it available for use by telephone companies and by service-station organizations to help extend service to more farms.

While the use of carrier-current systems to increase the number of conversations which can be carried by telephone wires on a pole line has long been an important feature of long distance telephone service, it has not heretofore been possible to design such systems for economical use on rural telephone lines to increase the capacity of the wires in place of stringing more wires on the pole line. It is hoped that, after the war, new developments will make this possible, and that carrier can be used on rural telephone lines as well as on rural power lines, both being to the benefit of farmers and farm service. Of course a major distinction to be made between these two uses is that carrier on rural telephone lines simply provides, in general, more circuits along established pole-line

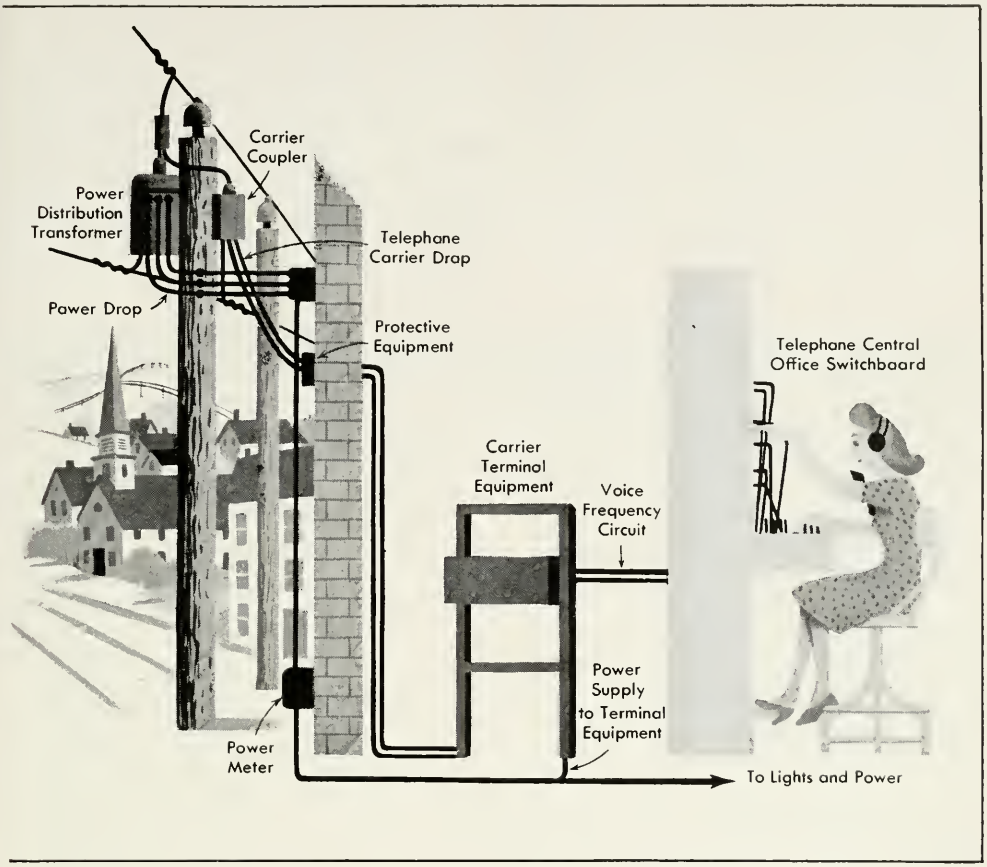
A POLE HOLE DIGGER makes quick work of line construction where ground conditions are favorable. A lighter machine is being developed for rural construction



A VISUALIZATION of the principal physical features of the "power

routes, whereas carrier on rural power lines may avoid the necessity of building or extending telephone pole lines.

THE TRULY remarkable accomplishments of radio telephony in the war have brought many suggestions for—and some fanciful pictures of—the peace-time use of this means of communication, particularly as an aid to farmers and others in isolated places. The Bell System has had a good deal of experience as to the place of radio in telephone communication, and will undertake further studies of its use for rural service as soon as the war ends. It has already requested the Federal Communications Commission to make available 40 frequency assignments for 20 rural customer circuits with which to conduct experiments and develop this type of service. These frequency assignments would be suitable to be duplicated over and over in different localities. Short-wave frequencies of the type contemplated have limited transmission ranges, usually not extending



line carrier" system designed to help in serving rural areas

further than the limit of vision, and it now seems likely that radio telephony for rural service may find its principal field in providing extensions of telephone service to farms so remotely situated as to be beyond the reach of even extended telephone pole lines or of power-line carrier.

These new methods of construction and new types of facilities form a powerful array for extending the scope of rural telephone service so that it should be possible to reach, on a reasonable basis, practically any farmer desiring telephone service for himself and his family.

Improvements in Service

The Bell System companies propose not only to make telephone service more readily available to all parts of the rural areas which they serve, but also to continue their program of making the service better and, as a consequence, more desirable. Originally, most rural telephones used the "magneto" type of system,

in which the subscriber must turn a crank to signal the operator. About three-fourths of the System's rural telephones now have the type of signaling used in cities, where the central office is signaled simply by lifting the telephone from its cradle. The companies propose to extend this form of service systematically, for the most part replacing the old form of magneto service with dial service and for the rest making available common-battery manual service.

For years, most rural customers were summoned to the telephone by what is known as code ringing. In this system, ringing on the line by an operator is heard by all subscribers connected to that line, and a code is used to indicate which subscriber is to answer. Now well over half of these telephones have some form of selective signaling, whereby the rings of only a part of the people on the line are heard by any one subscriber. It is hoped after the war to extend this use of selective ringing to substantially all rural customers.

A TELEPHONE MAN shows a group of interested farmers how to make a twisted-sleeve splice in their service-station line

The clearness of transmission on rural lines will continue to be improved. Much has already been done by changing grounded circuits to metallic circuits. The latest and most efficient types of telephone

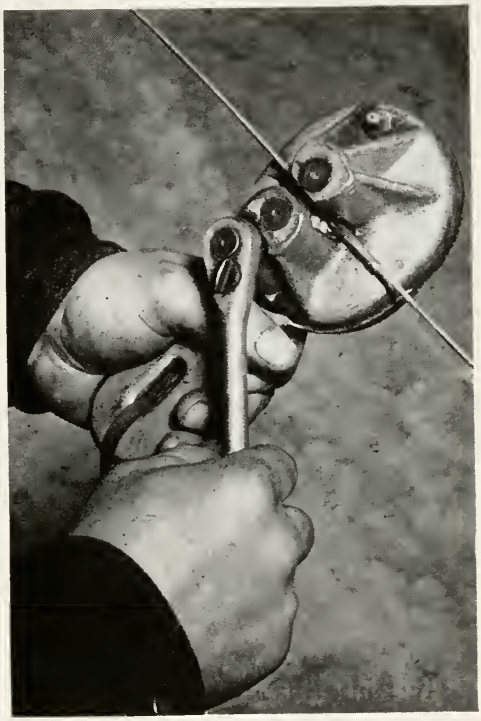
transmitters and receivers have been introduced in rural as well as in urban service as they have become available, and it is estimated that 60 percent of rural telephones are already equipped with them. This proportion will be rapidly increased after the war. Also, the number of subscribers per line, which because of war-time limitations has in some cases become greater than seems desirable for normal times, will be reduced.

The greatest increases in value of service come from these improvements in the quality of service and from increasing the number of people in a community who have telephone service. In addition, a number of System companies plan to make experiments in the further extension of information features, such as weather forecasts, bus schedules, and other items of direct concern to farm customers.

An important part of the service in rural areas is given by the mutual service-station groups already referred to. The Bell System has long recognized their importance in making nation-wide telephone service a reality, and the operating companies have made a point of assisting them in many ways—particularly since the depression. The companies have organized groups of experienced men whose function is to help these service-station groups. As the man-power situation eases after the war, even more of this will be done. Such assistance is broad in scope, ranging from advice on how a group should organize for service and build the line, to continuing assistance in connection with its maintenance.

Obtaining Basic Information

So great an undertaking as the Bell System's rural service program must build on a sound basis of fact and information, and inquiries and surveys are fundamental to it. Some of these are already under way, and will be expanded as, again, peace brings the men and the time to do so.



A new tool used in the Bell System to make an improved wire joint

Even now, a good start has been made on determining what people in rural areas think about telephone service: what they like and don't like about it; what they feel it should include; what improvements and new features would make it more pleasing

and useful to them. It may surprise some readers to learn, for example, that in one area more than half of the rural customers interviewed during these local surveys said that they did not object to "listening in" by others on the same line. When enough information has been compiled, from various sections of the country, it will be analyzed, and will serve as a guide in developing those aspects of the System program.

As a help in making final plans, detailed surveys will be made of many typical areas in various parts of the country. These surveys will be made by teams of men, from several departments of the telephone companies, who will drive up one road and down the next until a given section has been thoroughly covered, making careful notes as they go along. They will gather facts on such points as farm and non-farm establishments, present and potential telephone customers, whether telephone or electric power line passes the premises, present condition of the line, sections requiring pole-line construction, soil conditions, and other pertinent data. All this information will serve as a basis for engineering plans to provide satisfactory telephone service to present and new customers in the most economical way.

When an aggressive program of improvement and extension of service again becomes possible, telephone company representatives will go out to interview farmers and others who do not have telephone service; for the System's obligation, as the telephone companies conceive it, is not fully discharged simply by making the service available to as many people as possible. It is met only when, in addition, those who do not have service understand the basis on which they can have it, and appreciate its value in neighborliness, in emergencies, and in their business—for farming is a business. The telephone representatives' efforts will be supplemented by advertising through such means as farm journals and rural newspapers and at county fairs and other gathering places.

The plans are well along. Progress is being made now in advancing the program as fast as possible under war-time conditions. When materials and manpower become generally available, the farmer will reap full benefit of this program for extending and improving his telephone service.

The end of the war, moreover, will bring back the System's people now in the services—some 60,000 of them. The $100,000,000 rural program, with its objective of a million more rural telephones, will be an important factor in providing work for a considerable number of these telephone soldiers and sailors.

War Contributions Emanating from the System's Research and Development Organization Are Demonstrating the Value of Its Peace-time Methods and Ideals

Bell Laboratories in the War

Oliver E. Buckley

World War II is generally recognized as exceeding all previous wars in the demands it has laid upon science. There is scarcely any branch of learning which has not made important military contributions. Physics, chemistry, and mathematics have perhaps held the foremost place among the sciences in inspiring a procession of new weapons and new techniques. However, there is scarcely a department of science which has not rendered its indispensable, if less obvious, service.

Although everyone concedes the many war-time contributions which scientists and their specialized knowledge are making it is safe to say that not one person in a hundred understands the tremendous expenditure of time, money, and effort necessarily entailed in the actual process of focusing the nation's scientific acumen on military problems. All too often science is regarded as wizardy brought up to date, and so effective that brilliant discoveries and inventions can in weeks, if not in days, be translated into new weapons for the battlefield. The facts are quite otherwise, however. In reality, science usually provides only the foundation of knowledge on which inventors and designers systematically and patiently build. Much time and great engineering skill are required to convert the new ideas and designs into serviceable military tools. A successful laboratory demonstration or even a field trial of carefully conceived design almost invariably marks but the beginning of a long succession of testing and modifying, to be followed by more testing and more modifying. Months of hard work, much skill and, frequently, inspiration born of perspiration are the unseen ingredients of every successful new instrument of war.

In this regard there is little that is unique about reduction to practice in war-time. It is much like reduction to practice in peace-time, although under the stress of hostilities the urge for rapid completion of projects is naturally keener. The skills and techniques of pre-war industrial research have therefore been an invaluable war asset of the nation. When beset with a sudden demand to encompass in their arsenals as much of present-day science as possible, as well as to devise the most successful countermeasures to the enemy's ingenuity, the armed Services naturally looked to the laboratories of applied science as one of their chief sources of help. In these institutions they have found groups of workers whose profession it is to adapt science to practical ends and who have acquired great facility at it.

As the largest organization of this kind in the world, Bell Telephone Laboratories has been able to render outstanding assistance to the armed forces of the United States and of our Allies. The part it has played has been a source of pride to all of us who are its members. With scarcely an exception, everyone has had a chance to contribute directly to the war effort. Indeed, from what military authorities have told us, it is evident that the war would have been longer and its consequences more serious had the Services lacked the technical tools that have been devised and perfected within our walls.

To tell the full story of the war activities of Bell Telephone Laboratories would be impossible within the limits of an article of reasonable length or even a book of reasonable size if justice were to be done to the 1,200 or more projects on which major contributions have been made. One measure of its magnitude is its cost—well over $100,000,000—but that appears a poor measure indeed when one observes the variety and complexity of technical work which it covers and the military importance of the products which have emerged.

Even if it were practicable, considerations of secrecy suggest that the full story of our war work may never be told. As it can be released and as the time of those doing the work becomes available to tell about it, the more interesting parts will be described in appropriate technical articles. It is now possible, however, to give a general outline of our war activities, to indicate their character and distribution, and to explain the policies and methods of operation which have been employed in this most interesting and significant chapter of the history of Bell Telephone Laboratories. These policies and methods are not new, but are the natural outgrowth of our long-established methods of operation as a unit of the Bell System.

A Unique Organization

Bell Telephone Laboratories is in many ways a unique organization. It is not only the largest research and development organization but it probably covers a wider range of activity than any other similar group, even though in its normal activities its attention is focused on the single field of electrical communication. In that field it covers the full gamut of technical matters relating to the telephone, both wire and radio, starting with the very fundamentals of speech and hearing and the physics and chem-

istry of the various elements that make up the complex telephone plant. It combines knowledge gained from fundamental research with intimate knowledge of performance requirements in the design of instruments, apparatus, and equipment which it develops to the point where they are ready for production. It also tests out new products under actual conditions of use, prepares information for maintenance and operation, and continues to make studies of behavior of these products throughout their subsequent life.

In this work we as members of Bell Telephone Laboratories have only one objective: to make certain that the equipment that we devise and design will be such as will achieve the end of the best possible telephone service at the least possible cost. This is a very different objective from making things to sell in a competitive market. It calls for study from the users' point of view and takes into account the cost of maintenance and the value of continuity of service quite as much as first costs. In this process, too, we consider a piece of telephone equipment not as an item to be appraised by itself but as an operating unit of the system of which it is to be a part. From the very nature of telephony, it is essential that the parts of the system fit together and be engineered to that end to a degree required in few other fields. Consequently, "systems engineering" has played a dominant part in every aspect of Bell Laboratories' work.

The Murray Hill buildings of Bell Telephone Laboratories, designed to accommodate about 900 people, under pressure of war work now house 1,200. They include many novel structural features which adapt them to laboratory needs and make them perhaps the most outstanding buildings in the country for scientific research

Another feature that distinguishes the methods of Bell Telephone Laboratories is its close association on one hand with the Western Electric Company as manufacturers, and on the other hand with the Operating Companies of the Bell System. These as-

sociations make possible intelligent engineering of equipment for economical production as well as engineering for reliable service as part of an intricate system.

It is readily apparent that these methods, which have proved highly effective in relation to the Bell System, are equally adapted to the technical problems of producing tools of war designed to serve military needs. Add to this the fact that communication has played an extraordinary part in this war of rapid movement, and the even more significant fact that the techniques of communication have brought about revolutionary changes in many other military fields, and it is not surprising that we were in a position to make vital contributions to the effective prosecution of the war.

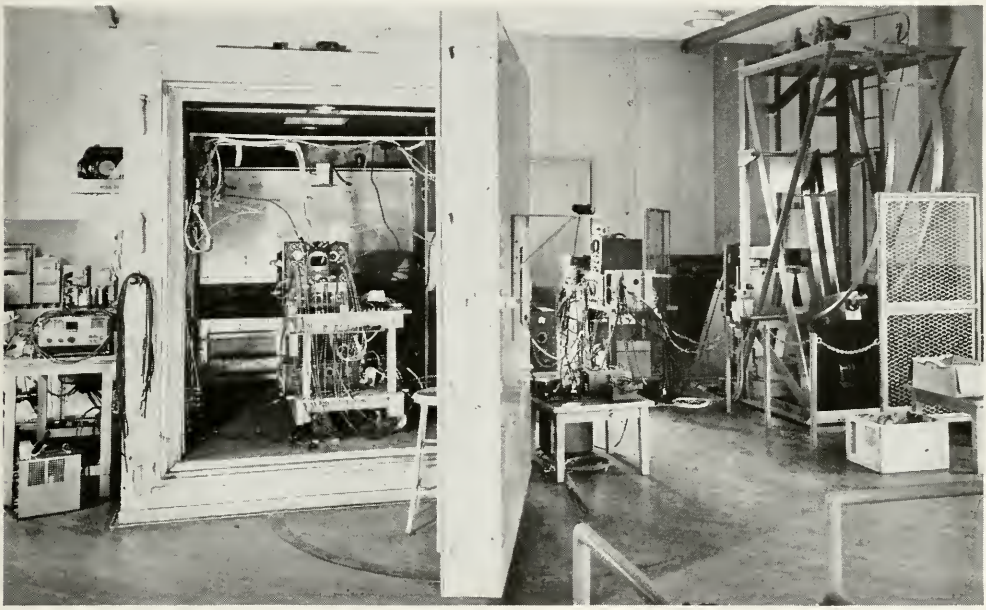
Actually, our entry into war work was gradual. Ever since World War I, we had maintained a department for serving agencies outside the telephone system in special applications of the techniques of telephony. A part of this work was in the field of radio communication for the military Services. As the Services began preparations for a possible conflict, their demands on us especially for radio grew, until by the time of Pearl Harbor 30 per cent of the entire activity of the Laboratories was on behalf of government war agencies.

A PEACE-TIME SCENE in one of the laboratories of the Switching Development department. The flight crew trainer was created in this department. The department's normal activities include the development of dial and manual central office switching systems for both local and toll service, and allied signaling problems

With the country's entry into the war, this effort expanded rapidly, until our efforts were soon almost wholly devoted to those problems where it seemed we could best play our part in the national effort.

We have contributed major developments in such diverse fields as communication systems and equipment, radar systems and equipment, devices for undersea warfare, and electrical gun directors; we have contributed new materials, devices, and techniques which have found important applications in fields far removed from our normal lines of activity. We have also engaged extensively in the manufacture of pre-production equipments, and have operated a large school for the training of Army and Navy personnel.

Although our first work connected with the war was in fact a continuation of military communication work carried on for many years previous, we had, prior to the war, engaged in other fields of war interest bordering on communication. Most notably was this so in radar development, which eventually became our greatest war activity. We started this line of work in 1937, in coöperation with the Navy, and by the time of Pearl Harbor had already made many significant contributions to this new art. In our communication experience we had



A CORNER of a Life Test department at Whippany, New Jersey. Models of military equipment developed and engineered in the Laboratories are always subjected to rigorous tests involving extremes of temperature and humidity. In the large chest at the left refrigeration tests are made, the equipment under study being operated and observed by means of the electrical connections seen hanging from it

a preparation for this line of development unequaled by any other laboratory. In many other fields, too, we found that the special skills and techniques which had been developed to meet telephone problems could be applied to new problems brought on by the war.

Developments in Wire Systems

In the field of wire communication, much of our war effort has related to the adaptation of existing arts to the needs of the Army and Navy. Portable equipments, specially packaged for use in the field, were built of standard parts using standard or near-standard circuits and methods. New kinds of wire and cable and new types of construction to meet the needs of modern warfare had to be developed. A great variety of new telephone instruments to permit talking in tanks, airplanes, and for use with gas masks were devised. A new multiple horn loudspeaker system, used extensively in both land and naval operations, is worthy of special note. Another very important contribution is the portable information center for the control of air operations; with it, all information is brought together at one point for directing the course of an aerial combat.

In a rapidly changing forward area, a backbone of wire communications which can be installed very quickly is a vital requirement of the Ground Forces. The system developed to meet this need employs the spiral-4 cable. This cable comprises four rubber-insulated wires symmetrically laid up to provide two balanced circuits, lightly loaded with loading coils inserted at the terminals of quarter-mile sections. On these circuits three telephone and five telegraph channels are normally provided.

Developments in Radio

Radio communication, from the development point of view, has weighed more heavily than wire communication because of the highly mobile character of the war and the less mature state of the radio art. In this field our principal activities have been in radio for airplanes, tanks, and mobile artillery, in overseas radio circuits, and in broad studies of radio communication systems. Airplane radio telephony has been a subject of continuous development in Bell Laboratories from its inception in our Laboratories during World War I. Although our armed Services were well prepared in this regard before going into the war, new conditions called for changes which could not have been foreseen, and modification of radio equipments had to be made to meet them.

The tremendous demands for radio communication among all kinds of moving vehicles of warfare called for great precision and great facility in the selection of radio frequencies. Quartz crystal control proved the key to this problem, and crystal-controlled sets were developed for tanks and other vehicles. Some sets use as many as 120 crystals, each adjusted to a high precision. The development of methods of cutting and grinding crystals with minimum waste of raw material became a major activity. Indeed, the supply of quartz became one of the major supply problems of the war and would have been critical except for the closest coöperation between the Signal Corps, the Western

Electric Company, and our Laboratories in the development of methods to economize its use. Through the Signal Corps these methods were made available also to other manufacturers and are now applied on a wide scale.

Signal Corps maintenance men are shown as they set up spiral-4 cable and messenger for Seventh Army communications. Many will recognize the characteristic French telephone line construction in the background

The overseas radio network of the armed Services is one of the most remarkable communication achievements of the war. It reaches to all corners of the globe and provides for a greater volume of communication than all of the pre-war radio and cable systems combined. The overseas radio links of this system make use of some of the equipments and methods developed in the Laboratories in the pre-war era for overseas telephony. By applying carrier telegraph techniques to short-wave telephone circuits, a degree of reliability of telegraph operation was secured that greatly surpassed the previous overseas radio telegraph art.

Shorter range point-to-point radio systems using ultra-short waves were also provided to both the Army and Navy. The basic elements for these military systems were drawn from our pre-war development of point-to-point radio for the Bell System, and,

particularly, from the radio link from Cape Cod across Massachusetts Bay and the link connecting islands in Chesapeake Bay with the mainland, each of which has been in use for several years.

So vital have extended radio facilities been to the American forces, that a study of radio systems as distinguished from radio sets became an early necessity. Emphasis on the performance of radio equipments as single units rather than parts of a communication system involving antennas, transmission paths, interference, and other factors extraneous to the radio set, was characteristic of much pre-war radio development outside of the Bell System. This situation led first to our being requested to undertake a study of radio communication systems to meet the needs of the Army Air Force; later this grew into a broader study of Army communication systems generally. The products of these studies have proved of great military value.

The Laboratories and Radar

THE DEVELOPMENT and pre-production of radar systems and equipment have, from the start, represented a large part of the war activities of the Laboratories. Radar components and testing equipments of the Laboratories have been used extensively in systems designed by others. Our outstanding position in this field is an outgrowth of our pre-war development of communication systems involving techniques and methods of measurement later applied to radar. Experience in the art of measurement made it possible, in turn, for us to progress rapidly in the development of various components essential to the success of radar techniques. These collateral lines of investigation have proved valuable not only for our own progress in the radar field, but for that of other radar development agencies in this country and England, to all of whom they have been made freely available.

Close coöperation with agencies of the National Defense Research Committee has occurred in this and other fields of development. Through this means, the research skills of many of the outstanding academic scientists of the country were combined with those of industrial scientists and engineers to meet in a most remarkable way the technical problems brought on by the war.

Underwater Sound

DEVICES for undersea warfare represent an important area of our war development effort and one of close coöperation with the National Defense Research Committee. Included are not only instrumentalities for detecting and protecting against enemy submarines and mines but also devices useful in protecting our own submarines. In this field, too, an important contribution has been our development of techniques and instruments for precision measurement.

One of the most important elements of undersea warfare is underwater sound, since radio is ruled out by the conductivity of sea water. At the beginning of our attack on problems of underwater sound, we undertook to develop methods of measurement. Automatic means for measuring the performance of underwater generators and receivers of sound were developed to the point that in the course of a few minutes the re-

sponse of a device could be determined with a high degree of accuracy continuously over a frequency range from 50 cycles to 100 kilocycles. Devices for producing and detecting underwater sounds had previously been designed largely by cut-and-try methods and without the benefit of quantitative knowledge of their performance. We supplied the means to design on the basis of precise knowledge. Proceeding in this manner, we developed new types of underwater sound instruments that have proved very valuable in the war. Included among them is echo-ranging equipment which represents a great advance over the preceding art. Again our measuring techniques were made available to other development organizations with consequent benefits to their producers.

Field artillery radio sets, such as the one installed in this command car, link forward observers with rifle and howitzer batteries in the rear. Similar sets are used for communication between tanks

The development of the electrical gun director comprises another important segment of our war program. This is a situation in which we proposed an electrical solution of a task which was being performed by a mechanical device. This solution makes use of electronic tubes and circuits

and of other components developed originally for communication purposes, and its success is now fully proved by its having been adopted as standard equipment in both British and American Armies. It played an important role at the Anzio beachhead, again in Normandy, and its latest triumph has been the part it has played in shooting down robot bombs in England. It has gained distinction for its reliability as well as its performance, and we take particular pride in the fact that it was wholly a Bell Laboratories product.

Other Developments

Among the miscellaneous developments that do not fall into any of the categories discussed above are items as diverse as airplane crew trainers, improvements in rockets, a shell velocity meter, means of increasing the wear resistance of gun barrels, gun silencers, computing machines, and numerous other items that appear to have little connection with communication. They do, however, have one thing in common, which is that they make use of techniques, methods, or skills developed specifically to solve problems of the communication industry.

A particular case in point is the airplane trainer developed for the Navy to train crews for flying operations. With this device, an air crew is enabled to "fly" a stationary replica of an airplane fuselage completely equipped with its regular quota of instruments and controls while an instructor sitting at an adjacent desk supplies the conditions to which the "plane" is subject in its "flight." Lacking only the mechanical motion of a real airplane, it presents to students conditions which might lead to disaster if they were met in real flight. This trainer has proved outstandingly successful, and models for three different types of airplanes have been developed to date. Such a machine involves as a principal feature electrical computing mechanisms giving the results of variations in a large number of independent and interdependent physical quantities. In this regard its development called for the same kind of approach and required the same skills as does the development of complicated automatic central office equipment. Use, also, is made of many standard telephone parts in its construction.

Development of special materials and studies of properties of materials have always been an important part of Bell Laboratories' activity on behalf of the Bell System. All of our specialized knowledge of materials accumulated over years of telephone development was made available to our armed Services and to manufacturers supplying them. Some of the principal items in this class are magnetic alloys, mica, rubber, natural and synthetic crystals, ceramics of special electrical properties, coatings to protect against corrosion and against fungus and other destructive organisms. In the case of mica, which was a critical material, means were developed to test and sort mica that enabled utilization of grades of mica which had formerly been rejected as unfit for use. In the case of rubber, one of our chemists was called on to lead the fundamental research program of the Rubber Administration, and means were developed in the Laboratories for measuring the degree of polymerization of synthetic

rubbers. In electrical ceramics, advances were made far beyond anything previously achieved, and as with other improved materials of our development the benefits appeared in others' products as well as our own.

Except for certain parts of the work on war projects which promise to have post-war telephone application, our war projects have been handled on contracts made by the Western Electric Company with the government agencies involved. About 55 per cent of such contract work is for the Army, about 35 per cent for the Navy, and about 10 per cent for the Office of Scientific Research and Development.

Our attitude on Army and Navy orders has been to give the Services what they ask for, endeavoring wholeheartedly to meet their performance requirements while making available to them opinions based on our own experience. We have engineered to our usual high standards just as far as considerations of time would permit, subject of course to our limited knowledge of conditions which must be met. As the Services began to bring back knowledge of actual combat conditions from fields of action, our engineers have taken this information into account, with consequent improvements in the quality and the utility of the products. Our equipment has given excellent service in the field and has reflected in the most significant way the benefit of our long-standing policy of engineering for service.

The *Elcobel* is one of two yachts used by the Laboratories for under-water testing. Their availability greatly expedites the trial, under actual seagoing conditions, of devices and modifications as they originate in the Laboratories

Ordinarily, the activities of Bell Telephone Laboratories are confined to research and development, including the current engineering essential to our broad development responsibility. The products of our devel-

opment are manufactured by the Western Electric Company, the manufacturing unit of the Bell System. At the request of that company and to shorten the time between the first model and quantity production, the Laboratories has undertaken to manufacture small quantities of pre-production war equipment. This manufacture of pre-production equipments, usually in quantities of 25 or 50, has grown until it is a sizeable business, running to well over $1,000,000 a month. In this production, as in shop work on our experimental models, we have, so far as possible, arranged to have parts and sub-assemblies made by outside shops, and have thus sub-contracted work to no less than 200 manufacturers.

PRE-PRODUCTION manufacturing in the Laboratories has expedited the availability of a small number of advance units for early training in maintenance and operation, a matter of great advantage to the Army and Navy. It has also expedited quantity production by giving the engineers of the Western Electric Company an opportunity to base their manufacturing planning on observation of the equipment under manufacture in the Laboratories.

In a number of instances the amount of equipment required by the Services has been so large that part of the manufacturing has been placed with other companies through subcontracts by Western Electric Company. Some of these companies later became prime contractors for the equipments upon which they first operated as Western sub-contractors. Thus a number of manufacturers outside the Bell System are now building equipment to specifications developed in the Bell Laboratories.

The School for War Training

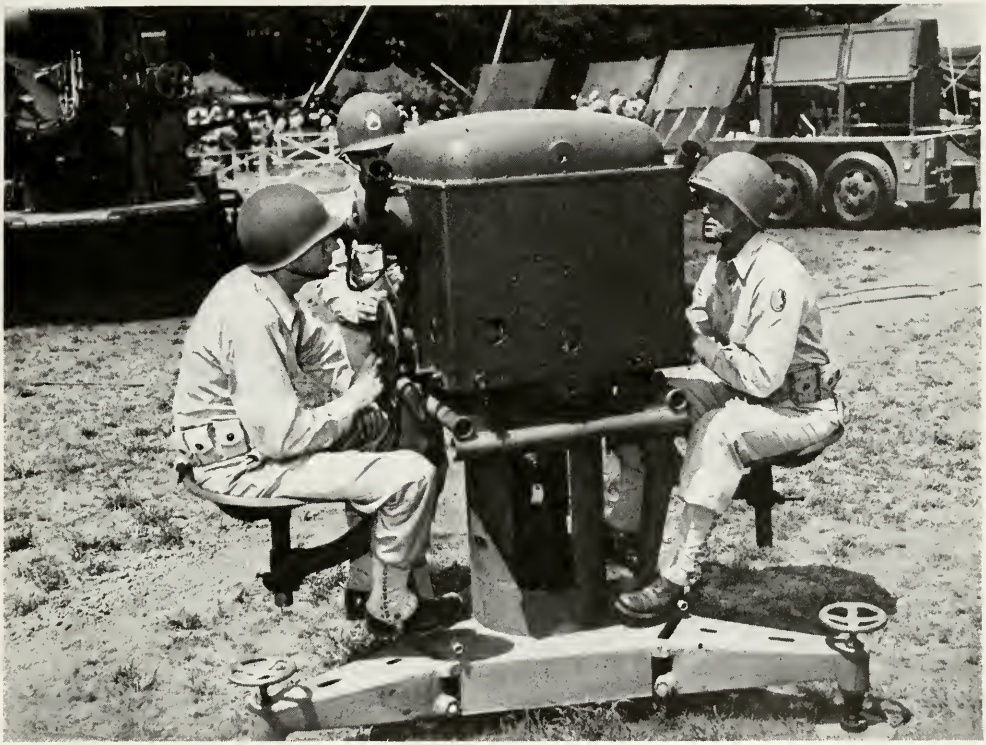
THE LABORATORIES has also taken a direct part in the Army and Navy training program through the Bell Laboratories School for War Training. Nearly 4,000 students have been instructed there in the utilization and maintenance of new special equipments in radar, fire control, underwater sound, and radio communication. So successful has this training been that the Navy now requires each combat vessel to have on board at least one officer graduate of our Laboratories School.

In conjunction with this school work we have prepared many of the instruction books for use with the equipments we have developed. A complicated piece of military equipment is of little use without a set of instructions. The preparation of such material has been a stupendous task, no less than 650 books having been written, many of them large volumes. Indeed, from the standpoint of number of new books published, the activities of Bell Laboratories exceed those of the largest private book publishing concerns.

IN ADDITION to the work done within the Laboratories, many of our outstanding scientists and engineers have served on government committees, including particularly various subcommittees of the National Defense Research Committee, More than 30 have been so engaged extensively and some have been loaned for full-time service while many others have served in limited capacities. We were governed in this by the desire to make

the most effective use of each individual's time in the national war effort.

Many demands have also been made on us for the transfer of skilled personnel to the Services or to the National Defense Research Committee. We have not always been able to meet these demands, for had we met all of them we would have had little technical staff left and it would not have been in the interest of the war effort that we do so. We have, however, transferred more than 100 professional employees to the Services and a small number to the National Defense Research Committee or its academic sub-contractors. In many instances, this loan of personnel to the Services, particularly where of limited duration, has been very helpful in our own work. The men who have come back from fields of action have put into our developments the



SHOWN HERE is a portion of an AA battery. In the foreground is the tracker unit of an electrical gun director. This feeds information concerning the position, speed, and course of hostile planes to the electrical computer. Through a suitable nerve mechanism the computer in turn aims the guns visible in the background, giving them the proper lead. As the planes move, the guns move too, being provided with a continuous "bead" by the electrical computer. In carrying out its instantaneous calculation, the computer takes account of all important factors, such as wind velocity, latitude, barometric pressure, and type of propelling powder

benefit of their intimate knowledge of conditions of use.

On top of all the war activities described above, the current needs of the Bell System have also been provided for. In fact, the war has induced many emergency telephone problems. Available materials had to be substituted for scarce ones in equipment being manufactured for regular telephone uses, and this called for much work in testing substitutes and changing specifications. The combined load of war developments and the war needs of the Bell System forced us early in the war to forego almost completely all of our normal lines of forward-looking research, so that we have continued to carry on only that telephone work which was essential to the efficient operation of the telephone system.

To meet the demands of the war program, it has been necessary steadily to expand our forces. We have grown from a group of 4,600 at the beginning of 1941 to about 8,000. Actually, the Laboratories is effectively somewhat larger, for, through outside shops and other work done on contract, we make direct use of the services of about 800 additional people.

While we have carefully controlled the growth of the technical staff so as to maintain its high quality, we have not hesitated to give its members all possible aid by providing assistants, draftsmen, and mechanics to speed the embodiment of the products of their imagination. It is the increase in this assistant technical staff, and in the clerical staff needed to keep pace with the growth in work, that has been principally responsible for our net increase in numbers during the war period.

However, the growth of the staff is by no means a proportionate measure of the increased output, for all have worked under abnormal pressure and for longer hours. Our normal working time of 35 hours a week for professional and office people has been increased to 48 hours and upward for all actively engaged on war work. Many have worked for periods far beyond those scheduled hours, and in some cases up to 80 or even 90 hours a week when it was evident that important war results depended directly on the speed of their immediate accomplishment.

It is a characteristic of the normal method of working in Bell Telephone Laboratories that responsibility is assumed at all levels of the organization. Our people are accustomed to direct action across organization lines. Our method, too, is outstandingly one of teamwork. Most of our problems in normal times call for a variety of skills and knowledge that cannot be the product of any one line of training, and direct contacts are made to bring together the specialized abilities that are needed. This procedure over the years has engendered a spirit of coöperative endeavor that is remarkable in so large an organization. That spirit, in a group predominantly made up of experienced personnel of outstanding quality and specialized skills, has made possible an output of new technical tools of war far beyond what any of us could have predicted. More than that, we now know that it has contributed materially to victory, thus definitely shortening the war.

As a Safeguard in case of Enemy Attack, an Alternative Telephone Line Was Constructed East of the Pacific Coast Ranges in Record-breaking Time

Building the West's New Telephone Route

Richard C. Smith

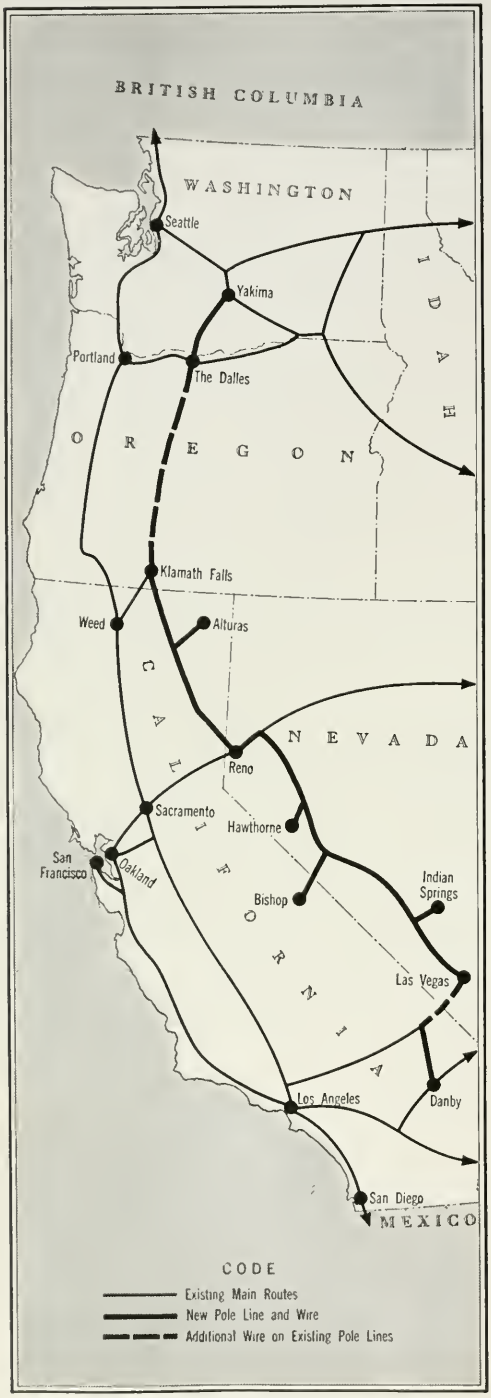
ONE OF THE most outstanding construction projects in Bell System history was completed in the Far West, in 1942, when a new 892-mile long distance pole line, wire stringing on a total of 1,317 miles of line, and the necessary repeater stations and equipment were engineered and completed in one-fourth the time which would ordinarily be required.

Stretching from central Washington to southern California, through mountains and desert which never before had echoed to the clatter of a construction outfit, the line represents a job in which telephone people everywhere can take a lot of pride.

"DBR" is the name by which this unusual line is known—the initials being associated, by those who were in on the job, with the phrase *Damned Big Rush.* Other names often used during construction days were *North-South Toll Lead* and the *Jackrabbit*; the latter for the speed with which it lit out across the country.

The line was built to provide a complete alternative telephone route paralleling the Coast east of the Sierra Nevada and Cascade ranges. Thus protected by mountain ramparts, the wires are relatively safe from enemy attack. The DBR job thus had a close connection with the war effort, and was carried out, as such, with "precision and dispatch."

Engineers and construction men of the Pacific Telephone and Telegraph Company got first wind of the proposed line about April 1, 1942. The project caught the telephone forces on the Coast with a good deal of work already on hand; far too much to take care of a mammoth task of this nature through the regular channels of organization. A new division construction organization was planned



RUNNING EAST of the coastal mountains, the DBR is linked with other important telephone lines

and staffed by the P. T. & T. to handle the major part of the job in northern California and Nevada.

A Big Job Undertaken

THE OVER-ALL PROJECT, from Yakima, Wash., to Danby, Cal., was to build the 892 miles of new pole line, string 7,700 pair miles of wire, construct nine new buildings and two building additions, and install additional central office equipment, including carrier and repeater apparatus. The new pole line comprised 707 miles in northern California and Nevada, 90 miles in Washington, 30 miles in Oregon, and 65 miles in southern California. Additional crossarms and from two to eight new pairs of wires were placed on 425 miles of existing pole lines.

The first step was to survey a route from Klamath Falls, Oregon, to Las Vegas, Nevada. The lay of the land was detailed by a photographic reconnaissance made from a plane. With one pilot flying north from Reno, and another south, photographs were made of every foot of the route. Taken from pre-determined altitudes of from 17,000 to 22,000 feet, these bird's-eye views showed just about everything; in fact, they proved so detailed that seemingly invisible markings of section corners and claims could readily be seen, when magnified and viewed stereoscopically. So closely did the completed line follow the path selected from the pictorial survey, that 95 per cent of the original route was unchanged.

The first use made of the aerial photographs was to study the route for rough spots, such as hills, mountain passes, canyons, and sinks, for they pictured a "condensed Nevada

desert" in detail never before available.

The next survey step was to stake the line, following the path of the aerial survey. Operating from bases at four towns in which living accommodations were obtainable, a force of 55 men footed it over their sections of the route. These men were immediately faced with the problem imposed by vast distances which are particularly impressive, not to say awe-inspiring, in sparsely-populated Nevada. A motor ride of some 60 miles to work in the morning, and home at night, was commonplace; the reason being, of course, that communities are very scarce, particularly away from established roads.

Although the survey went ahead rapidly, the engineers were sometimes in sight of the motorized telephone construction outfits which were following them. So close, in fact, that one chain man complained that "he hardly had time to get his hand out of the way" before a mechanical digger would be there to put a hole in. There was much good-natured banter between surveyors and construction men on this score; the latter claiming that the stakes were driven wherever there was sand—regardless of whether there was solid rock six inches under the surface or the stakes were propped up with stones if the sand was not deep enough! This was desert humor, for which there was daily need.

THE TELEPHONE ROAD. Built by telephone men in order to build the pole line, it stretches north and south as far as the eye can see

In the meantime, telephone engineers made estimates of the number of poles and the quantity of wire, hardware, and other material which would be needed. This was followed

by estimates of required repeater and carrier equipment and allied items. Orders were placed with the Western Electric Company, and wheels began turning at top speed in all parts of the country to make and send needed equipment and materials.

Full Speed Ahead!

THE PROJECT'S division construction office was opened in Reno with a complete staff of experienced telephone people. Every man in charge of a specified job—ordering materials, handling vouchers, bills, payrolls, hiring labor, etc.—was an expert of at least 15 years' Bell System experience in such work. This proficiency paid liberal returns on a job where know-how was vitally necessary, for there were many irons in the fire at the same time.

Before the construction stage of the project could be started, necessary approvals had to be obtained, priorities arranged, engineering plans completed, materials ordered and shipped, right-of-way problems investigated, and men, vehicles, and tools provided. There was the further need for establishing camps, pole yards, and bases for trans-shipment of freight from railroad cars to trucks.

The Pacific Company's territory is divided into four operating areas, whose names indicate their respective locations: the Washington-Idaho area; Oregon area; Northern California and Nevada area; and the Southern California area. Each area handled its own share of building the line.

The 707 miles of main and side leads in California and Nevada were divided into three districts and ten equal work sections; "equal" meaning a fair division of the work rather than distance, for some had rougher country than others. The longest section measured 82 miles, and the shortest 43 miles.

The construction force reached 640 employees at the peak, and averaged 522 men and women, including office people, to fill jobs ranging from division construction superintendent to temporary laborer. The Northern California and Nevada area was able to furnish all but 23 foremen and 112 linemen, and solved the problem of temporary laborers by recruiting junior college and high school boys for their summer vacation.

As none of the other Pacific Company areas was in a position to spare men, arrangements were made with the Bell System at large for personnel on a loan basis. The job thus became more than ever a Bell System family venture, the requisite number of foremen and linemen being borrowed from the Northwestern Bell Telephone Company, the Southwestern Bell Telephone Company, the Mountain States Telephone and Telegraph Company, the Illinois Bell Telephone Company, and the A. T. & T. Long Lines Department.

The temporary laborers were, in general, students from junior colleges and the California state agricultural school. A majority were husky members of football squads and—as was desired—accustomed to a hot, dry climate.

THE NEXT THING was to line up enough motor vehicles: a difficult assignment in war days, with every truck and tire as precious as a jewel. When the field had been looked over, it was found that all of the 123 cars

and trucks required could be furnished from the Pacific Company fleet, or purchased or rented on the coast, except for ten 1½-ton winch- and four 2½-ton digger-equipped trucks.

Here, again, the problem's solution became a Bell System family matter when the needed vehicles were borrowed from the Mountain States, Northwestern, Wisconsin, Ohio, Southern, and New Jersey companies and Long Lines. The trucks arrived in Nevada in good condition, newly painted, and ready to go when rolled from the freight cars—but destined to have this bloom of mechanical beauty soon removed by desert wind and sand.

By April 16, 1942, basic line material requirements had been figured and were set at: 30,000 poles, or about 300 carloads; 64,000 crossarms, about 54 carloads; 1,589,000 pounds, or more than 30 carloads, of line wire; and 1,000 anchors.

On a project of this size and urgency, ordinary routine would not produce desired results. While the usual practice is to order all stocked material on a single requisition, this line required quantities far greater than were carried by the Western Electric Company distributing house at Emeryville, California. "W.E.," therefore, placed many of the orders for direct shipment from the factories, and furnished the Pacific Company with groupings of items which could be ordered directly from individual suppliers with minimum handling and bookkeeping. W.E. also assigned the project a special block of requisition numbers which would enable the Reno office to have the numbered originator's copy for quick reference at all times, instead of having to send it to supplies headquarters

A typical supply dump beside the railroad in Nevada

The Service of Supply

THE JOB of the service of supply for the project was of such proportions as to make even veterans of other big telephone construction jobs wonder just how objectives were to be reached by scheduled dates. The fact remains that the line was completed well in advance of original "deadlines."

for numbering. This improvisation proved highly valuable, and was representative of the "Let's get the job done" coöperation shown by Western Electric people everywhere.

Supply control centered in Reno. Reports from the field and shipping information from Western Electric were coördinated through constant teletype communication with the telephone company supplies superintendent at Emeryville.

DIGGING POLE HOLES by hand in lava-boulder country

Getting poles on the construction scene was in itself a tremendous task, and the suppliers teamed up with railroads and others concerned to do a really fine job. Every hour in transit of the initial supply of creosoted pine poles from Mississippi and Texas was followed by telegraph. The whereabouts of each carload was known at project headquarters at all times, even though the rail lines were handling war traffic of unprecedented proportions. And when shipments of cedar poles from the northwest were held up because of heavy rains in the forests, there was some necessarily last-second routing of pole shipments to railheads of the various construction sections. To accomplish this emergency cutting out and switching, the freight cars had to be located while still east of Salt Lake City.

A steady flow of supplies was maintained with minimum waste of time and motion. The supervising construction foremen kept the project offices in close touch with supply requirements in the field, so that no critical shortages could develop in any of the sections. In fact, the foremen walked every inch of their sections in taking inventory of the material already in plant. How well this work was carried out is shown by the fact that all sections completed their share at the same time.

Construction Starts

THE SURVEY for the line was started on April 25, 1942, and the last stake driven on August 20. The first pole was set on June 15. The first step of construction work, which was to set poles equipped with crossarms and hardware, string wire for the top arm of the main lead, and build two side leads, was completed on August 31. The second step, of installing a second arm and wire and building a difficult branch pole line to Bishop, Cal.,

was completed on October 15. Final clean-up work was out of the way by November 20, and the project office was closed on December 1. From north to south, the job came out "even": the engineering and construction outfits met their schedules; all of the many repeater stations were built, equipped, and ready; the circuits were opened for service at the time planned!

Pioneers in the Wilderness

In the country traversed by the pole line, all of the mountain ranges and valleys run north and south, and there are innumerable dry lake beds and stream courses. A major part of the pole line is located above 4500-foot elevation. The range in climate and temperature on the route is extreme. On one day, snow fell along the northern California section while thermometers in southern Nevada soared to 109 degrees above. There was snow and sleet in the vicinity of Reno as late as June.

The members of the telephone crews were true pioneers in this limitless wilderness. Before trucks and machine diggers could get through to spot poles and gouge holes, a road had to be built. Bulldozers scooped away brush, small trees, rocks and sand. Trucks following this trail packed the surface into a passable road, except where the sand seemed to "go as deep as China."

The road and the telephone line are inseparable. They stretch through the forests and over the desert, as far as eye can see. Occasionally, where a particularly steep hill blocks the way, the poles march on over the crest while the road skirts the slope, in respect to the force of gravity and the limitations of mechanized equipment, however powerful. As time passes, the road will again be covered by sagebrush, and there may come a day when travelers will ask, "What road is that, and where does it go?" The proper answer by a historically-posted person will be, "That's the road built by the telephone fellows, back in '42 during the war. It leads north and south."

Dust hung heavy over construction operations almost everywhere

The line construction work entailed five principal operations: 1. digging pole holes; 2. setting the poles; 3. straightening and aligning the

A HINGED "sand barrel" helped in setting poles in loose sand

poles; 4. stringing the wires; 5. sagging the wires.

The Going Was Tough

POLE HOLE digging throughout the job proved more difficult than had been expected. Blasting operations for some 3,000 holes required over 13,000 pounds of explosives; or, otherwise expressed, holes for about 80 pole-line miles were blasted. In lava rock country, as many as 40 sticks of dynamite were used to blast one pole hole, and a 25-stick charge was not unusual.

Machine digging proved not too successful, as either rock or sand was encountered everywhere. In some places the surface was covered with material resembling fine ashes. When a machine digger was used, the men raked away gravel, sand, and rock brought up by the auger, to keep the hole from filling up. Even then, it was necessary to clean out most excavations by hand. In addition, at least 4,000 holes had to be dug entirely by hand, due to the nature of the surface or location of the job. Air compressors and integral gasoline engine drills were widely used. The holes were dug from 5½ to six feet deep and often would be five or six feet in diameter at completion, due to cave-ins.

Where water was close to the surface (there were three such places on the entire route), or in regions of deep sand and gravel, sand-barrels were used to keep the walls of the excavations from collapsing before a pole could be set. Sometimes a bulldozer would be used to dig a pit large enough for a cellar, in order that the sand barrel could be set at proper depth.

Wooden cribbing was built to protect poles on crossings of stream beds which were usually dry but apt to become torrents after cloudbursts and mountain thaws. Laced together with steel rods and wires, the cribbing was filled with rocks to form strong bulwarks against the storm waters and debris.

Copper-steel wire was substituted for copper wire, and effected a sizeable saving in this war-precious metal. The price, in this case, was a closer spacing of repeater stations on the line, since transmission losses prove greater when copper wire is not used. Large-scale changes of plans and materials put a heavy load on the supply

organization and Western Electric, of course; but everybody came through handsomely to help make effective these desirable though costly economies of scarce materials.

"Spotting" Supplies

Poles were delivered to the various railside yards of the project, and from there trucked to their locations, often more than 100 miles. Trucks equipped with derricks made easy work of loading the big sticks—although in one section, when a derrick broke down, a cowboy was employed to hitch his horse to a rope and roll the poles up skids aboard the truck. The results were satisfactory, although local progress was slowed somewhat.

Ordinarily, the truckloads of poles would be hauled along the "telephone" road and each pole unloaded at its site. In exceptionally inaccessible country, the telephone men carried the poles by main strength from roadside to the desired location. In other places, it was possible to attach a rigging to a boulder high on a hillside and, by use of a winch, "highline" the pole over obstructions. Elsewhere, tractors often "snaked" poles to the proper spots.

In the wake of the poles came truckloads of crossarms, which had been fitted with pins at the pole yard, and supplies of insulators and pole line hardware. The telephone crew, following closely, fitted each pole with crossarms and insulators and placed it in its hole. The raising was done when possible with the aid of a derrick, but in places where truck or tractor could not go, pike poles were used.

Next came men to straighten the poles and line them up with the rest of the lead. They, along with the other construction men, did their work so quickly and so smoothly that the pole line rose magically wherever the gang was at work.

With the poles in place, along came a truck carrying wire reels adjusted on a mechanism for "throwing" desired arrangements of wires for transpositions. While being unreeled, the wires were kept separated by various means, most often by threading them through rings on a stick carried by a man walking behind the truck.

At the end of the big construction parade came the wire-sagging crew. It was the work of these linemen to

It was sometimes necessary to pull wire by hand in mountainous country

adjust precisely the sag or slack in the wires, in accordance with tables set up for various temperatures and span lengths. The extremes of heat and cold along the route made this operation exceedingly important. The men illustrate this point by telling how the "dead-end" or tension pole, placed in one section of the line at the end of a day's work, was plucked right out of the sand when night's work, pridefully, "the many wires look just like a slender tube of copper."

The sagging was done by adjusting the slack in the wires until the desired tautness was obtained. Briefly, the process was as follows:—The linemen on the poles were in touch by telephone with the tension man at the end of the sag section, who regulated the slack in the wires by adjusting "slack

LAYING UP THE WIRE. The men on the poles are lowering ropes by which to pull up the unreeled wire

coolness caused the wires to contract.

Sagging was an exacting job because of the types of transposition and carrier systems used for service over the lead. The level of wire was not allowed to vary more than three-quarters of an inch per wire at any point between poles, except at transposition brackets, where the top wire is about one inch higher. "Viewed from the side," said the chief of this pullers" and tackle according to directions. The foreman, standing on the ground, directed sag adjustments from information obtained by timing with a stop-watch the oscillations of the wires. Further adjustment was made in individual pairs until the wires pulsed together five times in ten seconds, indicating a tension not exceeding one-quarter inch variation.

A big problem linked up with all

phases of line construction had to do with keeping the motor vehicles in repair and on the job. The rough terrain, together with abrasive dust and extreme heat, made regular maintenance a vital necessity.

There were many difficulties to be met in keeping enough of the fleet in operation to carry the men to and from work. This was due, in large part, to tire replacement rules and regulations which often forced vehicles out of service for as long as two or three weeks at a time, and to the fact that repair shops were available at only four widely separated towns on the entire route. These shops were always busy, so that the telephone trucks had to "join the crowd" and wait their turn.

Repairs to the digger trucks were made by inspector repairmen assigned to the job by the telephone company's motor vehicle department. The light trucks used by these men were well equipped with tools, pneumatic grease guns, and air compressors. Great care was taken to keep the tires of all vehicles properly inflated.

An innovation required throughout the desert country was a non-corrosive type of anchor for pole guy rods. Chemicals in the soil eat away the unprotected metal anchors and rods to pin thickness in two or three years. The "desert-type" anchor, made on the job, consists of a hollow block of concrete tapering to a broad base. Guy rods are covered with a tarry solution and wrapped with protective layers of paper tape. Next, the rods are inserted in the anchors. Then, with the aid of an ordinary tea kettle, the anchor is filled with the molten

SAGGING THE WIRE. In this precision operation the foreman, on the ground, times the wires' oscillations with a stop watch

One of the construction camps in the desert

solution, which completely encases the end of the metal guy rod, hardens, and makes the unit impervious to chemical action.

Whatever the problem to be solved, the gang developed a "won't be licked" spirit. They accepted seemingly impossible due-dates as a matter of course.

Interest of the men centered around the job, and there was plenty of rivalry between crews of adjoining sections to be the first to complete the work. The weekly progress of construction was charted in graphs made up by each of the supervising foremen, and the rise and fall of the columns for hole digging, pole setting, wire stringing, etc., brought forth not only the puffed chests of prideful accomplishment but also wails of dismay. Every foreman, it should be explained, was convinced that his was the toughest section in the entire route. And there were a few places on each section which convinced its foreman that he was right. There were plenty of times when the predicament of a neighboring outfit would bring chuckles of understanding: that would be, perhaps, when a foreman's crew had gone swiftly for miles down a straight and easy stretch with all phases of construction, only to reach a range of rocky hills or a boggy sink, where every pole hole was a major operation.

Home on the Range

The construction camps were an integral part of the project, and were important to its success, since good living conditions for the men were needed to counteract isolation and the discomforts associated with desert life in summer. A commissary company was engaged to operate the camps, agreeing to furnish food of high quality and sufficient quantity to satisfy active and hungry men, and to make living conditions as pleasant as desert life permits.

The typical camp was made up of wooden buildings similar to the structures in today's Army camps. There was a barracks for the telephone crew and one for the cook's crew; a mess hall and kitchen; an air-cooled recreation hall fitted with games, tables, and benches; a storeroom, a tool house, bath house and washrooms. Water was hauled to camp in tank trucks.

The use of wooden buildings, rather than tents, was determined by the extremes of temperature experienced, and the wind and sand storms prevalent in summer. The sand storms were like dry, hot blizzards, during which the air would be so filled

with sand that it was almost impossible to find the way from one building to another, and the wind was a destructive and painful sandblast. In late summer there were the usual cloudbursts of high altitudes which built up streams and torrents in a minute's time, only to vanish as quickly.

Very few—only about 15 or 20 out of 400 temporary men—quit the job before their respective sections of line were completed. All members of the 23 crews from eastern companies were experienced telephone men; but, by and large, out of 50 or 60 men at a camp, only about 20 were regular telephone employees, and many of these had been with the company for less than a year.

The older men shared their "know-how" of telephone work, and let the young fellows have their fun at day's end. The boys, it should be said, ran true to form in vitality, and thought nothing of a ball game right after supper, regardless of what hard work had been done. Chief wonder, however, was their limitless capacity for food. The mess halls served more than 81,000 meals. Vouched for by the plant operating assistant in charge of camps, and plenty of witnesses, is the fact that 50 men in one of the camps drank 25 gallons of milk in one evening! The usual daily intake for a camp was 25 gallons of milk and 25 gallons of lemonade.

The men who lived in towns along the route had the advantage of seeing other people, attending movies, and being a part of community life. Where accommodations were satisfactory, they were given room and board in hotels. One crew was quartered in a small town's one hotel and fed in a mess hall set up by the telephone company. It was here that the postmaster organized a baseball team made up entirely of telephone boys, who won all 12 games played with teams from far and wide, including some crack service teams.

The job had a safety record worth talking about. The engineering de-

Good and plentiful food for hearty appetites was provided in the mess shacks

partment did not have one lost-time accident. The construction department had only two comparatively minor lost-time accidents. This despite that fact that the new men, while in excellent physical condition, were not used to construction work or versed in safety methods. New men are always more prone to accident than their experienced fellows. The good showing made indicates that everybody followed closely the Bell System's safety motto: "No job is so important and no service is so urgent that we cannot take time to perform our work safely."

The draft was a cause for some concern, in that employees were constantly being called for physical examination and induction. The situation was helped somewhat, for the men themselves, when arrangements were made for transfer of records from home-town selective service boards to a board nearest the place they worked. The continual drain of help from the job imposed a great many problems for the telephone organization, however, since the labor turnover due to the draft was considerable.

The men who worked on the DBR project were "tops" in every respect. Never was there dissension in any camp, and they seemed to have a mutual understanding that enabled them to get along famously with one another. After the project was completed and the men had gone home, the parents of nearly 100 of the boys communicated with company supervisors to say how much they appreciated the good treatment and care their boys had received.

A SUMMING UP of the spirit of the personnel and its accomplishment is best made by the division construction superintendent, who knew them all on a first-name basis. He said:

"The question has been raised several times as to how it was possible for this construction organization, composed as it was of so many new people, to accomplish the work that has been done and to meet all of its objectives on time. The only answer is that each individual on the job, and particularly all those chosen for key positions, accomplished all that could have been reasonably expected—and more. To their loyalty, courage, and hard work our company owes the accomplishment of the objective requested. Associated Company personnel cannot be praised too highly; they were rugged, experienced construction men, especially picked by their home people for their ability, and they arrived imbued with determination to do a good job. The sentiments of the entire gang can probably be best expressed by their often repeated hope to be in on the next big one."

The Bell System Pioneered in Providing Facilities Which Made Network Broadcasting Possible, and It Can Provide Them for Post-War Frequency-modulation Programs

FM Program Transmission: A Bell System Service

The A. T. and T. Company recently prepared a booklet, bearing the above title, for the information of people in the radio broadcasting industry and others having a special interest in the subject. The subject is also of interest to many people in the communications industry, and the booklet is therefore reprinted here. Modulation, and the difference between the usual kind of broadcasting and frequency-modulation broadcasting, may seem fairly complicated matters to the non-technical reader, however; and a simple explanation of them, in the form of a letter to a friend who had asked for enlightenment, may serve as a helpful introduction.

DEAR PETE:

You asked me what FM is; and, when I said that it was FREQUENCY MODULATION, you said, "First, what is MODULATION?" Let's try to clear up this question. Here goes.

MODULATION is the variation of the characteristics of an electric current or wave to enable it to carry intelligence.

Now don't let that scare you. Let's consider an example. In the simplest telegraph circuit, signaling is accomplished by the operation of a telegraph key which controls the current flow from the battery. When the operator presses this key, the current flows; and when he releases it, the current stops. The electric current in this simple telegraph circuit is turned on and shut off by this key much as the flow of water is controlled by turning on and off a faucet. We may say that the flow of current is MODULATED by the operation of the key, or broken up into short or long parts called dots and dashes which are employed for the transmission of messages.

MODULATION, in most cases, is not simply turning the current on and off. Just as a faucet may be adjusted to any position between closed and wide open to produce any desired flow of

water, so the flow of electric current can, with suitable devices, be similarly controlled. A telephone transmitter or microphone is one device which enables such control of a current to be accomplished, the strength of the current being controlled by the pressure of the sound waves reaching the instrument. In a simple telephone circuit, the strength of the current from a battery is so controlled; this current may be said to be MODULATED by the sound waves, and its strength at any instant is a measure of the pressure of the sound waves reaching the transmitter or microphone.

IN THE antenna of an ordinary radio broadcasting station we have a different kind of current; not a battery current, but a high-frequency alternating current. This current is similar to the alternating current used for house lighting and power purposes, except that instead of flowing back and forth 60 times per second, as such currents do, it races up and down the antenna hundreds of thousands of times per second. The number of to-and-fro excursions or "cycles" per second is called the frequency of the current, and in ordinary broadcasting stations is between 500,000 and 1,600,000 cycles per second.

The current from the microphone in the studio of the transmitting station is, however, similar in character to the current in the simple telephone circuit which we have considered. This telephone current is employed to control the strength of the high-frequency current in the broadcasting station antenna. We say, then, that the antenna current has been MODULATED by the music or voice. Its strength follows the variations in sound in the studio just as the strength of the battery current follows the variations of the voice in a simple telephone circuit. The waves radiated from the antenna similarly carry these relative variations in strength, or amplitude.

SO FAR, we have been talking only about the kind of MODULATION where the strength, or amplitude, of electric currents, or waves, is varied; and this is AMPLITUDE MODULATION. There are other kinds of MODULATION, the best known of which is FM, or FREQUENCY MODULATION, about which you were asking. We have already considered the fact that the current in a broadcasting station antenna is a high-frequency alternating current. The waves radiated from the antenna are, similarly, high-frequency waves. In the case of FREQUENCY MODULATION, the frequency of the antenna current, and consequently the frequency of the waves that it sets up in space, are varied instead of their strength, or amplitude.

When no modulation is taking place, the frequency of the waves radiated by the broadcasting station antenna remains constant at the assigned value. For example, if such a station were assigned a frequency of 45 million cycles, the current in its antenna would continue to surge back and forth in the antenna 45 million times each second as long as there was no modulation taking place. However, when the announcer spoke or music was played, the frequency would dance about, each change in sound pressure which reaches the studio microphone causing a change in fre-

quency of antenna current to occur. The antenna current in the radiated waves would then no longer have the constant value of 45 million cycles, but would vary through a range from about 44.95 to 45.05 million cycles. The antenna current and the waves are then said to be FREQUENCY MODULATED. Their strength or amplitude remains unchanged, the intelligence in this case being transmitted by means of varying the frequency.

At the receiving point, a circuit arrangement in the radio receiver called a "discriminator" converts the variations in frequency back to changes in current strength, and the loud speaker in the receiver converts these into pressure changes in the air. The end result is a sound wave having characteristics like those of the sound wave that reached the microphone in the broadcast studio.

As FREQUENCY MODULATION systems transmit intelligence by changes in frequency, receivers used with this type of transmission may be designed to be responsive primarily to such changes and to respond very little to changes in radio signal strength. This serves to reduce greatly the noise, or "static," due to the radio receiver picking up extraneous electric waves, and is one of the important reasons for the present great interest in the use of the FREQUENCY MODULATION system.

This may not make the matter as clear as spring water, but it's the best I can do here and now. To go further, it would be necessary to employ diagrams and use mathematics. If you want me to do this, let me know, and I'll give you the works.

As ever,

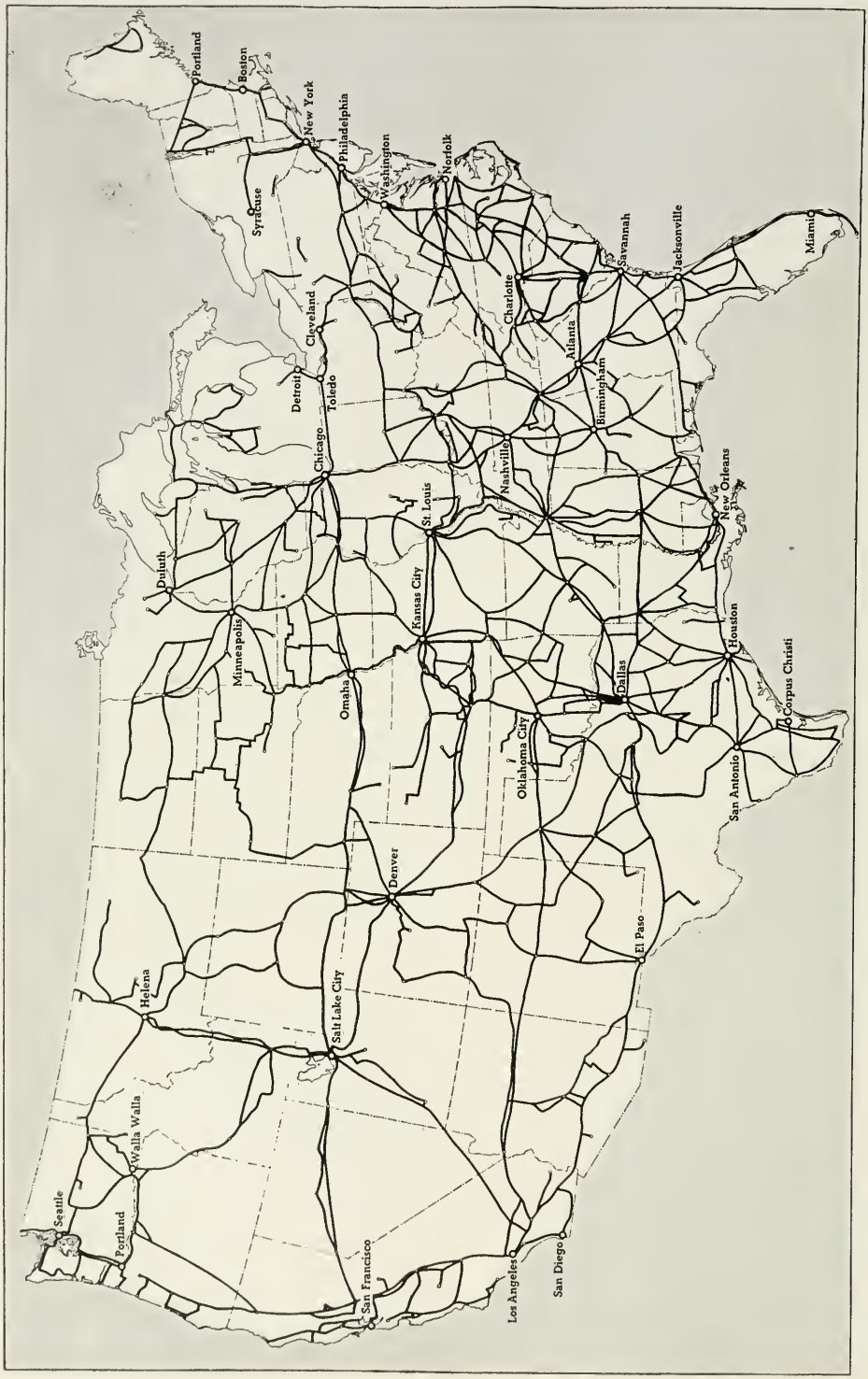
GEORGE

ONLY ABOUT 20 years ago, network radio broadcasting was an unknown art. Today, radio listeners everywhere can hear the same program at the same time. The Bell Telephone System pioneered in this development by designing and furnishing wire circuits over which programs could be distributed to many radio stations simultaneously. At the present time, the System maintains and operates more than 130,000 miles of these "program transmission" circuits, interconnecting radio stations regionally and from coast to coast.

Now comes an important development in radio: Frequency Modulation. Today, networks for FM broadcasting are in their infancy, just about where the first networks were 20 years ago. And once again the Bell System is prepared to contribute its knowledge and experience to the service of the broadcasting industry.

Nobody can say exactly what FM will do in the next 20 years. However, FM broadcasters should know that the Bell System is prepared to meet their post-war needs for studio-transmitter links, for circuits connecting FM stations in regional or nationwide networks, and for local channels required to pick up programs originating outside of the main broadcasting studios.

Bell System facilities for these purposes have been tried and tested. They will meet all present and future



Bell System routes over which frequencies of 15,000 cycles or more are now transmitted for telephone purposes. Such lines can be used for 15,000-cycle program circuits by adding suitable terminal equipment

needs of FM broadcasters with respect to fidelity of transmission, freedom from noise, and control of distortion.

15,000-Cycle Circuits?—Yes

To what extent will FM stations be grouped to form separate networks? What quality of inter-city channels will these networks require? The answers to these questions will of course be determined by the broadcasting industry itself. Whatever is decided, the Bell System will be able to furnish inter-city circuits of the kind needed, including 15,000-cycle circuits if they are desired.

The Bell System is already furnishing 15,000-cycle channels for studio-transmitter links to the majority of all FM stations now in operation. These are giving satisfactory performance, demonstrating through practical experience that reliable arrangements can be provided.

Studio-Transmitter Links

Engineering standards established by the Federal Communications Commission for FM broadcasting specify that a frequency band of 15,000 cycles must be transmitted from a station's main studio to its transmitter.

In general, FM transmitting stations are located either within cities on tall buildings, or near cities on hilltops or mountain peaks.

In the first case, the distance between studio and transmitter is usually short, and no special construction or transmission problems are involved in providing a satisfactory wire channel.

When transmitters are located at more remote points, some special con-

struction may be required to establish the channel. So far as transmission requirements are concerned, the Bell System can readily meet them. At the start of the war, 15,000-cycle channels were being provided to some 20 FM stations over distances ranging up to about 25 miles. When the circuit is less than 8 or 10 miles long, intermediate amplifiers are not usually needed. Longer circuits differ from those ordinarily provided to standard broadcast stations principally in that additional intermediate amplifiers are required.

Beside furnishing such 15,000-cycle links to FM stations, the Bell System has for years provided many other broadcasting stations with studio-transmitter channels transmitting up to 10,000, 12,000 and 15,000 cycles. This emphasizes the fact that FM in itself presents no new problems. There is, indeed, no question that the Bell System can render FM broadcasters a service which meets the test of economy and at the same time fulfills all requirements of performance.

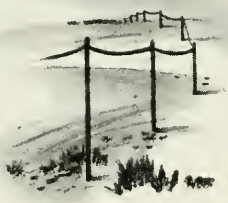
Network Circuits for FM *Stations*

At present, regular network facilities in general use by broadcasters are being employed to bring distant programs to FM stations. There are strong indications, however, that the number of FM stations will greatly

increase in the immediate post-war period. Furthermore, it may well be that separate networks for FM broadcasting, using program sources of their own, will be desirable on a regional and eventually on a country-wide basis.

Whatever pattern emerges in the future, the broadcasting industry is entitled today to know the answer to this question:

Can the industry rely on the Bell System to provide program transmission channels which will preserve for FM network broadcasting the advantages of high fidelity, and freedom from noise and distortion, which are



characteristic of the Frequency Modulation method?

The answer is emphatically *yes*.

For many years, wide frequency bands have been transmitted over long distance telephone carrier systems which make it possible to send many telephone and telegraph messages over a single pair of metal conductors. The map on page 258 indicates the extent of present Bell System facilities which now are capable of transmitting frequencies of 15,000 cycles or higher for telephone purposes. On many other routes also, circuits can be so equipped if they are needed.

To adapt these lines for 15,000-cycle program circuits requires addition of special terminal equipment. The dates on which such equipment can be provided will depend largely on how soon materials and manpower become available for its manufacture. It is expected, however, that the Bell System will be able to keep pace with the growth of FM stations and their need for channels of this quality.

Progress Through the Years

BEGINNING with the pioneer days of network broadcasting, and through the years, the System has kept pace with—has, in fact, anticipated—the needs of broadcasters for network channels.

In accordance with the indicated preference of the broadcasting industry, the main sections of the wire channels furnished by the System for network broadcasting were set up to transmit a frequency band about 5,000 cycles in width. For 10 years before the war, however, in anticipation of possible future needs, all program transmission facilities installed by the telephone companies were generally designed to be adaptable to the transmission of frequencies up to 8,000 cycles. Early in 1941, when broadcasters evidenced interest in improving the quality of transmission over nationwide networks, the System offered 8,000-cycle channels. Shortly thereafter, war imposed limitations on the use of materials for this purpose. There is no other limitation, however, on the System's ability to provide circuits of 8,000 cycles or more.

As early as 1933—more than a decade ago—the System successfully transmitted frequency bands up to 15,000 cycles over circuits between

Philadelphia and Washington. These experimental circuits were set up to transmit to Constitution Hall, in Washington, a symphony concert produced in Philadelphia by the Philadelphia Orchestra. Practically the entire audible range of musical tone was transmitted. At that time the System announced that circuits of the type employed, "while not now available for use on a country-wide basis, can be made available should commercial requirements develop."

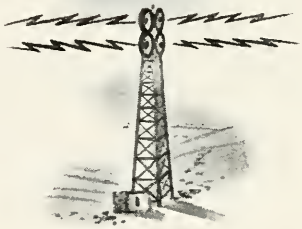
Eight years later, in the winter of 1941, the Bell System demonstrated the relative quality of transmission of 5,000-, 8,000-, and 15,000-cycle frequency bands over a 2,000-mile circuit. This demonstration was before the American Institute of Electrical Engineers. The 5,000- and 8,000-cycle circuits were of the type now used in program transmission. The 15,000-cycle circuit employed a standard carrier telephone system to which had been added special terminal equipment—equipment expressly developed for 15,000-cycle network service should the need arise. It is this type of circuit which the System will have widely available in the postwar period to serve broadcasters who may have need for 15,000-cycle intercity channels.

Local Pick-Up Channels

For FM programs originating outside of the studio, local circuits within cities and metropolitan areas can be provided to connect the broadcasting point with the station's fixed facilities. On these circuits, frequencies up to 15,000 cycles can be transmitted by adapting regular telephone plant for program use. Such channels, meeting rigid noise requirements, have already been provided for some of the FM broadcasting stations.

Wire or Radio Links?

So far, we have been speaking of wire circuits to transmit FM programs. However, if other means should prove better or more economical, the Bell System will use them. The System is in the communications business and will use the best means that can be developed, whether wire or radio, for transmitting broadcast programs as well as other forms of communication.



One evidence of this is the American Telephone and Telegraph Company's current undertaking to build a radio-relay system between New York and Boston. This trial installation is of a type which was under development by the Bell Telephone Laboratories before the war. It applies to radio communication many of the techniques which have played an important part in the development of long distance telephony. Directed radio beams at ultra-high frequencies will operate simultaneously in both directions, and will be relayed at stations about 30 miles apart.

The purpose of the trial is to learn from actual experience the relative advantages and disadvantages of

broad-band transmission by radio, compared with other means. This purpose applies to the transmission of various types of communications, including long distance telephone messages, television, and broadcast programs.

For FM broadcasters—in fact, for all broadcasters—the experiment will help greatly to define the relative merits of wire and radio channels for program transmission. There is no doubt that wire facilities give dependable, satisfactory service at reasonable cost. The question to be settled is, "Can radio-relay links give equally good, or better and more economical, service?" The Bell System expects to answer this question with facts drawn from experience.

WHAT HAS BEEN SAID in this booklet reflects an important objective of the Bell System—to do everything it can to further the progress of broadcasting operations everywhere. The System's intensive study of the characteristics of sound; its research toward finding and using the best methods of transforming these sounds into electrical impulses and transmitting them clearly over great distances; its vast physical facilities available for this purpose; and, not least, the wealth of experience and skill acquired in the operation of nationwide program networks over a long period—all these give assurance of future service to the broadcasting industry that will be of increasing value to broadcasters and the public.

IN A recent landing operation against a Jap-held stronghold in the Pacific, our Navy used 700 to 800 warships. These vessels were equipped with 48,166 telephones, according to Navy Department estimates, and these shipboard telephones were connected by some 5,000,000 feet of telephone cable of various sizes. The 48,166 telephones involved in that one naval operation are about equal to the number serving a city the size of Flint, Michigan, or Youngstown, Ohio.

Here is dramatic evidence of the vast quantities of communications equipment required to wage global war. It assumes even greater proportions when the single operation is multiplied many times over by equally large naval units in action on both sides of the globe. Added to the Navy's requirements are the tremendous communications needs of the Army's ground and air forces and of stationary installations around the world.

The Navy figures help to answer the question of why telephone facilities are scarce on the home front. They indicate something of the additional amounts of equipment which will be required before the war against Japan is won.

An Allegory about Diamonds Leads into a Non-technical Exposition of the Many Factors of Toll Circuit Engineering Which Affect Provision of a Nation-wide Network

Providing Paths for Long Distance Calls

Ralph I. Mabbs

JOHN dialed "Long Distance" with incisive strokes. He was calling Gramp out in Arkansas. Gramp was probably in the shed by the barn, perhaps repairing a toy for the kid up the way. Gram would have to go out and call him, but John had to talk with him. This was to be no personal telephone call, but an honest-to-goodness war call—an important one. John was playing a hunch.

Diamonds! Not the jewelry kind necessarily, but diamond points for cutting tools, were needed in John's war plant, and maybe Gramp could help. A small package of them, all the plant possessed, had been lost—or stolen. Unless he could locate some soon the plant would have to shut down. Big Town, near which his plant was located, had been scoured with no success, but Gramp . . .

A little brook tumbled down across the barren black rocks on a remote corner of Gramp's farm. It wasn't this that stirred John's boyhood memory, but Gramp's story of how he found among the black pebbles on its clear bottom one or two small heavy stones each year, some of them worn bright and sparkling. Could they have been diamonds? Gramp never knew, but it was worth a try to find out.

John knew that the long distance lines were extra busy these days, but he didn't know that a storm had broken a telephone line normally used to reach Gramp's town hundreds of miles away. Would that mean no path for this important call? Let's see.

To the operator's answering "Long Distance," John replied, "I want to get Burnt Rock, Arkansas, 475-ring-3."

"Routes to Burnt Rock, Arkansas?" John heard, and knew his operator was now asking a route operator how

Yes, diamonds *are* found in Arkansas. More than 10,000 have been found in Pike County one of more than 40 carats.

to reach Burnt Rock. "TC Little Rock via Memphis, 'A' route St. Louis," came the reply.

Then John heard his long distance operator say to a tandem operator, "Memphis."

Tandem, an intermediate operator who makes connection to the long distance circuits, came back with "OD and NC," which meant to the long distance operator that some of the circuits to Memphis were out of order and that all of the others were in use. She must try to reach Little Rock by way of St. Louis, as the route operator had instructed when she said "'A' (alternate) route, St. Louis."

John's operator, again to the tandem operator: "St. Louis."

In a moment he heard the St. Louis operator identify herself as "St. Louis."

John's operator then asked for Little Rock, and the Little Rock operator came in with "Little Rock."

The long distance operator passed on Gramp's telephone number, "Burnt Rock 475-ring-3," as given to her by John.

John listened with interest to this dialogue. He had heard it many times before, and it always gave him a feeling of pleasant anticipation as he seemed to feel himself advance nearer and nearer to Gramp's old farm.

Presently he heard the Burnt Rock operator identify herself, and Little Rock ordered, "475-ring-3." Softly came the intermittent hum of the ringing signal, and then Gram's familiar "Hello."

Easy? A turn of a dial, a buzz, an order given, a few seconds of dialogue between operators, a ringing signal, and a familiar voice. We recall that the long distance lines were extra busy and we haven't forgotten that a storm had disabled some of the telephone plant in the path of the call. Yet, there it is—well, I guess you can say it's easy.

Easy, because there were plans and experience and thought and study. Management, staffs, manufacturers, engineers, installers, operators, maintenance people, and the rest of the telephone team had worked together with one aim, that this call, representative of any call, might result promptly in a satisfactory connection.

How the Call Went Through

THE TELEPHONE CIRCUITS over which connections are made between Big Town and Burnt Rock had been distributed among several geographical routes, so that, should one of them become out of order, others between the same points still could be used. All John's operator had to do was to route the call around the trouble. When she learned the route via Memphis was not available, she tried by way of St. Louis—and got through.

To get the picture more clearly, let's turn to Fig. 1. We'll let *A* represent Big Town, from which John was calling, and we'll call the rural community near which Gramp's farm is located *L*. Long distance calls from *A* are handled by the Long Distance office in that city, and long distance connections to telephones in *L* are made by the Long Distance office at *K*. *K* is known as the toll center (abbreviated TC) for *L*. Thus, when the route operator at *A* prefixed "TC" she meant that Little Rock is the toll center which makes long distance connections to Burnt Rock.

The normal route of John's call, the one tried first by the operator at *A* to Gramp at *L*, is via *H*. If for any reason, however, the route by way of *H* is blocked, or all of the circuits are in use, calls are rerouted via *G*. That then explains what the route operator at *A* meant when she said, "'*A*' route St. Louis." If Burnt Rock could not be reached via Memphis, it might be reached by way of St. Louis—an alternate or '*A*' route.

The circuits between *A* and *H* are shown in Fig. 1 as assigned to two different geographical routes, some through *E* and others through *F*. If, as in the case of John's call, one of the routes is out of service, circuits over the other route still can be used. This, of course, throws an unusual amount of traffic over the circuits on the other route. That is what the tandem operator meant when she reported "OD and NC"—abbreviations for "out of order" and "no circuit."

The alternate route via *G*, you will note, also is protected, because some of the circuits are routed via *C* and others via *D*. Although it is not always possible to assign the circuits between two cities to more than one route, the arrangements for rerouting calls over alternate routes, as well as the division of circuits among several geographical routes

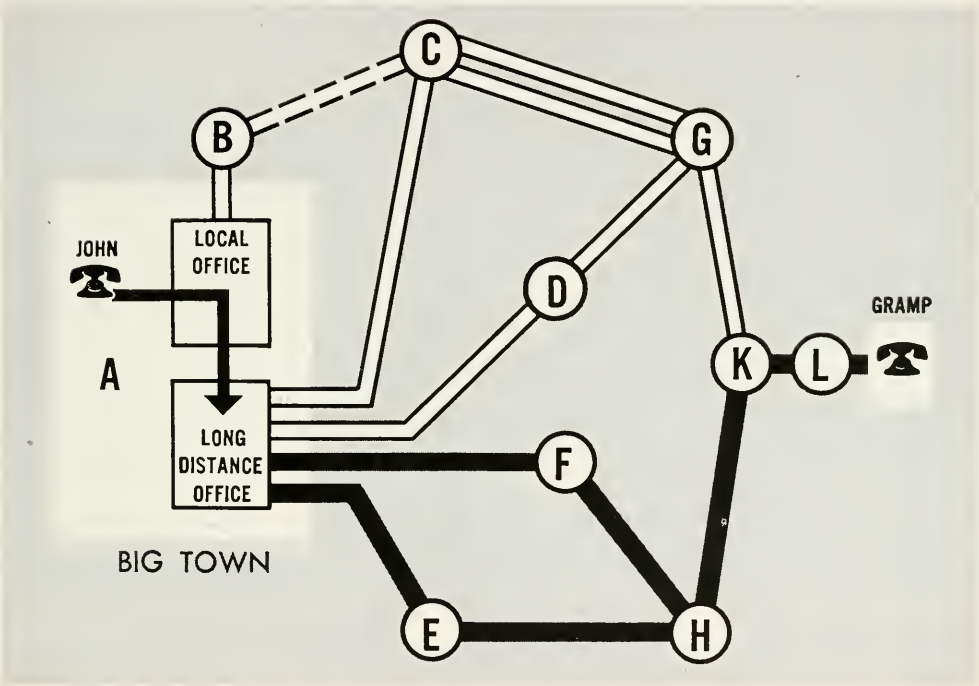


FIGURE 1. Routes available for John's call to Gramp

where this is possible, very largely prevent the complete interruption of service between two cities except in the case of damage to plant over a very wide area.

Another important factor of protection also is illustrated in Fig. 1. At Big Town, *A*, we find both a local dial office and the Long Distance office. In *A*, as in all metropolitan areas, calls between the large city and the nearby smaller places such as *B* are normally handled by the local operator at the dial office, who makes connections directly with the adjacent city without going through the Long Distance office. Because there is a path for calls out of the city which doesn't involve the Long Distance office, protection is provided against isolation of the city should a disaster put the Long Distance office out of service. For example, the local operator could go through *B* to *C*, where connections may be had to other cities in the network of long distance circuits that covers the country. This is, however, an emergency route, and unsatisfactory for normal use.

Providing Just Enough Circuits

We have followed the path of John's call from his Long Distance office to Gramp's farm, but what about the step between John's telephone and his Long Distance operator? Many others in Big Town no doubt were calling Long Distance at the same time that John was. It is necessary, therefore, to have more than one path from John's local office to Long Distance. The number required in order that all those who wish to reach Long Distance during the busier hours of the day can do so promptly had been calculated from estimates of the number of calls and from experience over many years regarding the percentage of telephones from which long distance calls will be placed at about the same time.

Here are some data about the paths from your telephone to Long Distance that may surprise you. They are normally provided in sufficient number so that during the busiest hour a signal appears before the long distance operator on 98 percent of the calls in less than three seconds; on the average for the total day a signal appears at Long Distance on 99.9 per cent of the calls within three seconds. During the busiest hour only about one call in a hundred should find all of the trunks to Long Distance busy, and for the total day only about one in a thousand should encounter this condition.

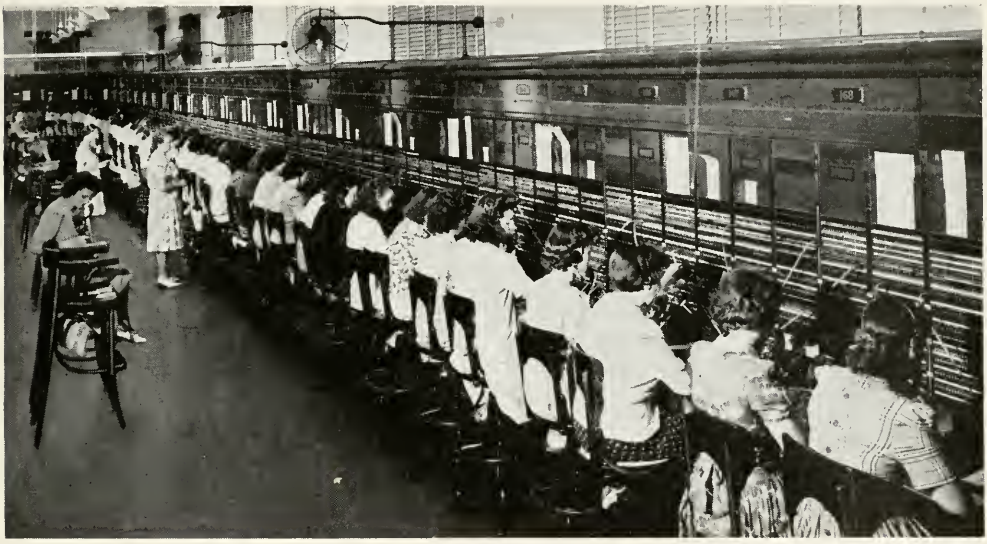
John had been having difficulty in getting raw materials other than diamond tool points for his war plant. The telephone company no doubt was having the same difficulty, he thought. He wondered how many lines there were between his office and Gramp's farm; how the telephone company was able to foresee the number required at any particular future time, obtain the raw materials, manufacture them into wire and apparatus, install the facilities at the proper locations—and have them in service when needed even under war-time shortages of material and excessive volumes of calls.

It takes many months to manufacture and install long distance telephone circuits; but even before the circuits can be ordered from the manufacturer, the number of calls

they will be required to carry at any one time, and the average length of time that a circuit will be used on each call, must be estimated. In addition, there are often unusual load conditions, such as those resulting from a sudden storm, an armistice, or a World's Series, any of which may send the volume of calls sky-rocketing and overload the circuits. Plans must be made for these peaks.

and holidays, of course, are busy times for social calling.

Long distance circuits often cover great distances. Miles of cables and wire and hundreds of pieces of intricate apparatus and parts must be manufactured, rights of way obtained, poles set or conduits laid; special construction across rivers and over mountains must be planned; and additions to long distance offices and



". . . the long distance lines were extra busy." The number of toll and long distance conversations totaled 1,400,000,000 in 1944

Another factor to be considered, of course, is the calling habits of telephone users. Mondays and Fridays, for example, frequently are heavy days for business traffic, and in some offices as much as 15 percent of the total calls of the day regularly occur during one busy hour. Unusual cases have occurred where half of the calls on certain days were made during a two-hour period. Evenings

their associated electrical equipment must be manufactured and installed with each new increase in the number of circuits.

It seemed clear to John that the speed with which his call could be completed depends upon the number of lines in each link of the connection. If there are enough to handle the volume of calls, then the connection would be made promptly; if too few,

then he would have to wait until someone else finished talking; if too many . . . but that would be wasteful and expensive!

Distance and Time Factors

It is an interesting fact that the greater the distance between two telephones, the longer the average connection between them lasts. At 100 miles the average conversation lasts about four minutes, while at 3,000 miles the average is about seven minutes. Since the percentage of calls that encounter all circuits busy depends in part on the average duration of the calls, distance becomes a factor in determining the circuit requirements.

The number of circuits directly connecting two cities, the mere size itself of the circuit group, affects the number of additional circuits that must be added to care for each percentage increase in calls. To demonstrate this, consider a large and a small circuit group over both of which it is desired to give the same speed of service. With a large fully loaded group of, say, 25 circuits, calls are ending frequently and those waiting take their turn in reasonably rapid succession. In this case the circuits are kept almost continuously busy, because when a call ends the circuit is taken up immediately for use on the next call.

Now consider a small circuit group of, say, two circuits. When both circuits are busy and a third call is offered, the chance of a circuit becoming free promptly is very much less and the wait of the third call may be considerable. In order that the wait may be about the same as that on the larger group, more circuit time per call or fewer calls per circuit must be provided for on the smaller group. In consequence, the percentage of the time that the circuits in the small group are kept busy is much less than that for the large group.

The effect of group size is illustrated in Fig. 2. The telephone engineer uses just such a table as an easy means of finding the number of circuits required for various volumes of calls. This is only one of the several tables from which he chooses the one most representative of the service requirements for the circuit group he is considering. His tables, of course, are more complete, showing circuits from 1 to 50 or more. Note that the calls per circuit increase rapidly as the number of circuits increases and that the percentage of the time that the circuits may be used for a given grade of service likewise increases with the number of circuits.

Number of Circuits	*Number of Calls*	*% of Time Circuits May Be Used*	*Calls per Circuit*
2	14	58	7
7	63	75	9
25	254	85	10+

Figure 2. The effect of group size on the number of circuits required

Thus it is that the number of circuits between the towns and cities of the country is the result of a multitude of interrelated conditions and factors, some depending on the habits of the telephoning public, others upon intricate mathematical calculations, still others upon the elements of nature, and over-all upon the good judgment of telephone engineers and managements.

Engineering Problems

It might be thought that in the orderly growth and expansion of the business and social life of the country, once the telephone plant had been built to fit its needs, all that remains to be done is to continue to expand as the need develops. Unfortunately, this is not the case. It is true that the long distance plant has evolved from a few circuits connecting the larger cities that are not too far apart to a network that permits the interconnection of all of the cities and towns in the country. The number of circuits between cities has grown with the demand for calls between the cities and the territory surrounding them. Where there were the greatest number of calls there came to be the largest number of circuits.

Business calls naturally occur most frequently between the large financial and industrial centers but, as more and more people installed telephones in their homes, the usage of the service for social purposes increased. Business calls are placed mostly in the daytime, while social calls tend to be more numerous in the evening. There is a tendency for social calls to reach out into the smaller cities and villages to a greater extent than do business calls. This is brought sharply to attention at such times as Thanksgiving and Christmas, when business calling decreases and social calling increases manyfold, building up heavy traffic loads to the small towns and filling the main trunk routes between large cities normally used for business calls.

Such sudden shifts in the distribution of traffic continuously present knotty problems to the telephone engineers who rearrange the long distance plant, built to fit one pattern of needs, to meet another set of demands brought about by rapid changes in calling. Any mass movement of people that tends to shift the population centers calls for extraordinary measures to meet telephone requirements.

In a thinly populated part of the country, a forest or plain with little telephone plant in it may within a few months be transformed into the equivalent of a large city by the establishment of a military training camp. This sudden shift of population takes large numbers of men away from the towns from which they usually make their telephone calls to a point where new telephone plant must be built to handle their calls. The plant serving their homes is now used but little by them and must be duplicated with similar plant at the new location. The fact that a large number of people have moved from one place to another has made it necessary not only to build new plant to serve them, but also has created for them a new need for calling and they make more calls than they would had they not moved.

Business conditions themselves sometimes change rapidly and the number of long distance calls may increase at a rate far greater than can be foreseen. Allowances are made for reasonable variations from the estimates of calls, but should the rate of growth in a locality change quickly to, say, twice the normal rate, it may be found extremely difficult to match the increase in calls with additions of long distance circuits, due to the time required to manufacture

and install new circuits. When such unforeseeable changes occur there may be periods when some callers must hang up the telephone after placing a call and wait for a circuit to become available. So well have the demands for service ordinarily been met that the American people have come to take it for granted that telephones and circuits will be available when they want to use them and that the service will be fast and accurate.

Dialing Long Distance Calls

JOHN'S CALL was handled manually by his long distance operator and the other operators along its path. To another place his long distance operator might have dialed the connection.* On dialed calls, the long distance operator dials a number for a circuit, just as John had dialed the long distance number. The tandem switches connect her to a circuit to H, further dialing brings her to K and L, after which she dials the called number. This service also is fast and accurate, and has technical advantages that will permit even faster, clearer, more accurate service as our country moves into its next stage of progress.

The time may come when it is possible for the customer to dial from one telephone to any other telephone in a very large area; but the magnitude of the problems, one of which is placing at the disposal of the calling party up-to-date information regarding the telephone numbers in distant places, makes it appear at present that the best long distance service will for a long time be furnished when an operator handles all calls to the more distant places.

There are many kinds of paths for long distance calls. Some are composed of just two wires, others use four wires, in other cases four wires provide ten or twelve paths. In one type of construction a tube with a wire in its center provides many hundreds of paths. Transoceanic and ship-to-shore paths use radio. Some paths are designed for manual operation, others for dialing. How many are required between two places? How shall they be routed? The answers to these questions are at the heart of the Bell System's responsibility for nation-wide service, and represent the part that telephone engineers play in the constant endeavor to provide clearer, quicker, and more convenient service to all.

OH YES, about John's call to Gramp! In spite of storm and busy wires the call went through while John remained at his telephone. Gram called Gramp to their telephone and that night he was on the train with his bag of heavy stones. There were diamonds among them and the war plant did not close.

And now Gram's knitting needles click a little faster as she listens while Gramp spins yarns to the kid up the way about his trip to Big Town and how he and John helped win the war.

* See "A Dial Switching System for Toll Calls, MAGAZINE, Winter 1943–44.

The Bell System's Manufacturing and Supply Organization, Now an Arsenal of Communication Equipment for Our Armed Forces, Marked Its 75th Anniversary in November

Western Electric's First 75 Years: A Chronology

Frank H. Lovette

The Western Electric Company's 75th anniversary was observed throughout the Bell System last November, and the following pages constitute a brief outline of the company's history. Telephone people will find implicit the interdependence among Western Electric, Bell Telephone Laboratories, and the Associated Companies, in war no less than in peace; and will realize that much of Western Electric's present war production cannot be discussed in detail because nearly half of it consists of "restricted" items.

On many a dark day of the War between the States, a visitor to the inner sanctum of the War Department at Washington might have found President Lincoln and Secretary Stanton standing in the wire room beside a brown-eyed, ruddy faced young Army Colonel, all three gravely scanning the telegraph register tape as it rolled out code messages from the battle fronts.

Sometimes the President and Secretary anxiously awaited decoding of those historic messages, a job the young Colonel, Anson Stager, readily accomplished, since it was he who had invented the secret cipher. Military authorities of the Confederacy had not deciphered it, and the war would end without their succeeding in doing so. When urgent messages had to be transmitted, Col. Stager frequently replaced one of the operators and sent them personally.

Col. Stager, then Chief of the United States Military Telegraphs, had been an operator since 1846. He was the first to receive by sound; he had devised both the common battery and long lines systems

Elisha Gray

Enos M. Barton

Anson Stager

Francis R. Welles

Charles E. Scribner

Founders, builders, presidents of the Western

of telegraphy; and as field agent for major telegraph interests he had convinced the railroads of the necessity of the telegraph as a safety device, arranging pole and line rights of way along their tracks. He had been a principal negotiator in the consolidation of warring companies which united to form the Western Union Telegraph Company. His work with McClellan in establishing the first military field telegraph system had won him authority over all military communications.

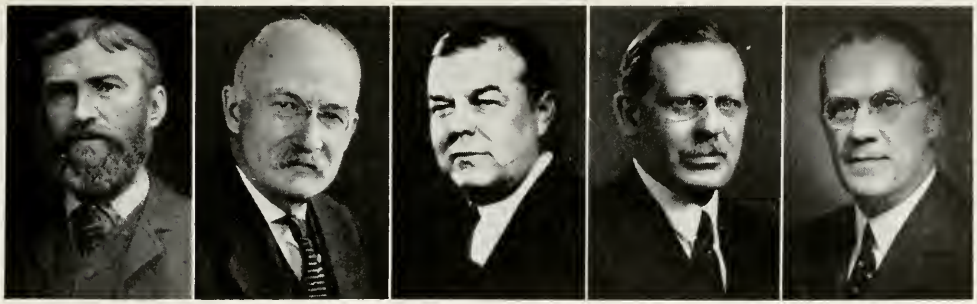
The Young Telegrapher

A SIMILAR VISIT to the Military Telegraph Office at New York during this same period might have found there Enos M. Barton, a young operator barely out of his 'teens, who also was a marvel of telegraphic speed and accuracy. He handled press dispatches from the war zones. Despite his youth, he was already a veteran telegrapher who had started "pounding brass" at the age of 12. A young man of impressive appearance, he had the broad forehead and deep set eyes of the intellectual, and spent much of his spare time reading good books. After his long and laborious day, often longer because of double shifts or wire trouble, he attended New York University's night school to increase the education begun at the University of Rochester, where he had worked his way through Freshman year.

At the close of the war Col. Stager, retired as a Brigadier General, returned to Cleveland as Western Union's general superintendent.

Enos Barton was transfered to Western Union headquarters at Rochester, where he became chief operator. In his new job, he examined and tested new inventions in the field of telegraphy. In December, 1868, his friend and fellow telegrapher, young Tom Edison, came to Rochester to try out his newly invented double transmitter over a circuit between Western Union headquarters and New York City. This and similar experiences convinced Barton that a great unexplored field of invention and development awaited the application of human genius in the electrical communications industry.

About the time of the Edison test, Barton had another visitor. The



William S. Smoot | Harry B. Thayer | Charles G. DuBois | Edgar S. Bloom | Clarence G. Stoll

Electric Company during its 75-year history

newcomer was George Shawk, who until a few weeks before had been foreman of Western Union's Cleveland repair shop. Shawk brought interesting news.

"I've bought the shop," he told Barton. "If I had you in Cleveland, we could do great things." He went on to describe his prospects for electrical repair work and the manufacture of fire and burglar alarms.

During this conversation Shawk disclosed that his shop was making models for the inventions of a former Oberlin College physics professor, Elisha Gray. "He wanted to go in with me," Shawk added, "but I turned him down. I told him I didn't want the shop entirely given over to his darned fool inventions, but right now he's our best customer."

The Enterprise Is Started

That meeting had far-reaching results; for a few days later Rochester's chief operator Enos Barton resigned that post to embark on his first business venture: the purchase of a half interest in George Shawk's shop. The down payment was set at $700, and Barton had but $200; but a family friend endorsed his note for $500, and agreed to help further when the final payment came due. Barton's mother voluntarily placed a mortgage of $400 on their family home to help her son finance his undertaking.

As soon as the first of these arrangements had been completed, Barton departed for Cleveland. The day he arrived and went to work, doing everything from tidying up the office and keeping the books to handling correspondence and outside sales and helping the "hands" operate the foot lathes, marked the real beginning of the Western Electric Company.

The formation of the new firm of Shawk and Barton was announced in the *Journal of the Telegraph,* and the junior partner went to board at the home of Professor Gray. Their kindred interests developed an immediate friendship. Barton had a long range conception of expanding the business into a manufacturing plant which could meet the demands of the dawning electrical era, already freely predicted by men of science. Professor Gray's inventive genius projected plans of great diversity and

scientific acumen which in themselves were a challenge to the shop's facilities.

Both Gray and Barton knew General Stager, probably the most experienced electrical communications authority in the United States, and had his active encouragement. During a conference among the three men, a partnership was proposed, and Stager agreed to consult his lawyer. The next day, when the two younger men returned for his answer, he told them his lawyer had advised that "confidence in the character and abilities of his partners would be his only protection." That statement must have cast a shadow over the hopes of Gray and Barton, but in the next moment Stager told them he had that confidence, and would attest it materially. Accordingly, he advanced Professor Gray $2,500 with which to buy Shawk's half interest in the shop, and himself took an interest in the Gray printer telegraph. That was in April, 1869. He agreed to become an equal partner at such time as they could arrange to move the business to Chicago, and the agreement was consummated on November 18, 1869.

During the next two years the little firm enjoyed a rapid growth, gaining an enviable reputation for integrity and for quality workmanship. It manufactured telegraph apparatus, fire and burglar alarms, the Gray printer telegraph, and other electrical devices.

Western Electric Manufacturing Co.

When the great fire of 1871 ravaged Chicago, all seemed lost. But the fire was extinguished within two blocks of the shop, and the emergency service of Gray and Barton won public approval and brought unprecedented business in supplying equipment and installations to replace those lost in the fire. The service rendered the Western Union Telegraph Company in restoring its local communications system so won the admiration of that company's officials that three of them joined with Stager in financing and organizing in 1872 the $150,000 Western Electric Manufacturing Company as successor to Gray and Barton. The new corporation took over the assets and organization of the shop and also Western Union's Ottawa, Ill., shop. With this acquisition, Western Electric became the largest manufacturer of Western Union's Morse instruments and began greater production of Gray's printer telegraph.

Sales increased, new lines were added, and Western Electric co-designed the first commercial typewriter with the Remington Arms Company of Ilion, N. Y., and for a time acted as sales representatives marketing the first typewriters the Remington Co. manufactured. By 1876 the Western Electric trade mark had gained high prestige in the electrical equipment field, and at the Centennial Exposition held that year Western Electric won five first-class awards for devices of its own manufacture. In 1876 also, the same year in which Alexander Graham Bell received his famous telephone patent, the company began manufacturing the Edison "electric pen," predecessor of the modern mimeograph.

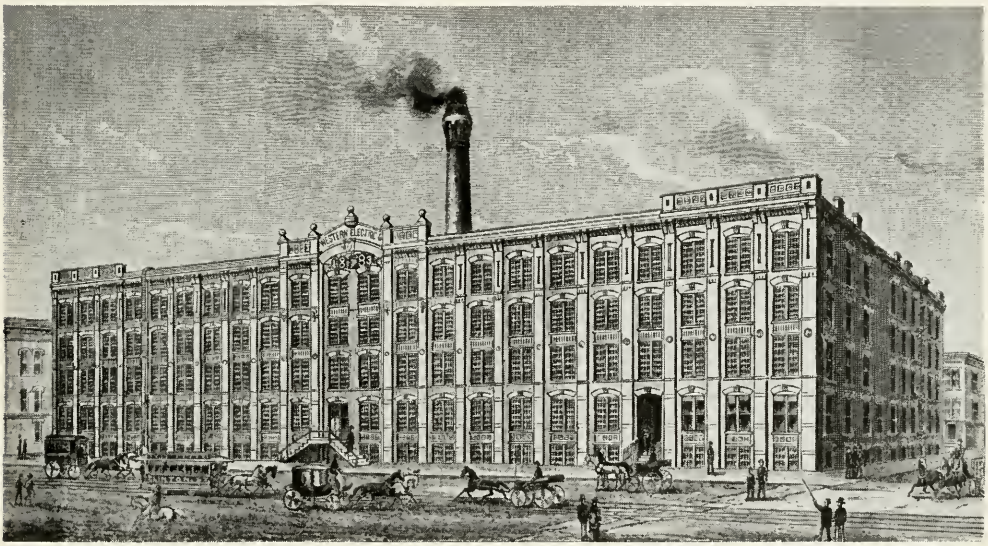
During these significant days of 1876, Barton hired two youngsters who were to have prominent parts in

shaping the future of Western Electric. They were F. R. Welles, the Company's first stenographer, and Charles E. Scribner, called the "boy inventor" because he was still in his teens and had already invented an improved telegraph relay. Before he was 21, young Scribner invented the jack switch which revolutionized telephone central office equipment and made the switchboard practical for interconnection of a great many subscribers.

Western Electric first began to manufacture telephones in 1877-78 under license of the Western Union Telegraph Company, which had bought the patents of Gray, Edison, and Dolbear. By 1879 Western Union Telegraph's telephone business was expanding so rapidly that it turned over to the Western Electric Manufacturing Company its New York shop at 62–68 New Church Street.

It was believed by the then officials of the Western Electric Manufacturing Company that, as in the case of telegraph equipment, apparatus which accomplished the same purpose without detailed duplication did not infringe upon the patents for other apparatus of different fundamental design. But a patent controversy arose between Western Union and the Bell interests, and during the taking of testimony in the Dowd case of 1878–79 the controversy was settled by a compromise in which Western Union withdrew from the telephone business and surrendered its patents to the Bell Company in consideration of a 20 percent royalty upon all telephones rented in the United States during the tenure of existing patents.

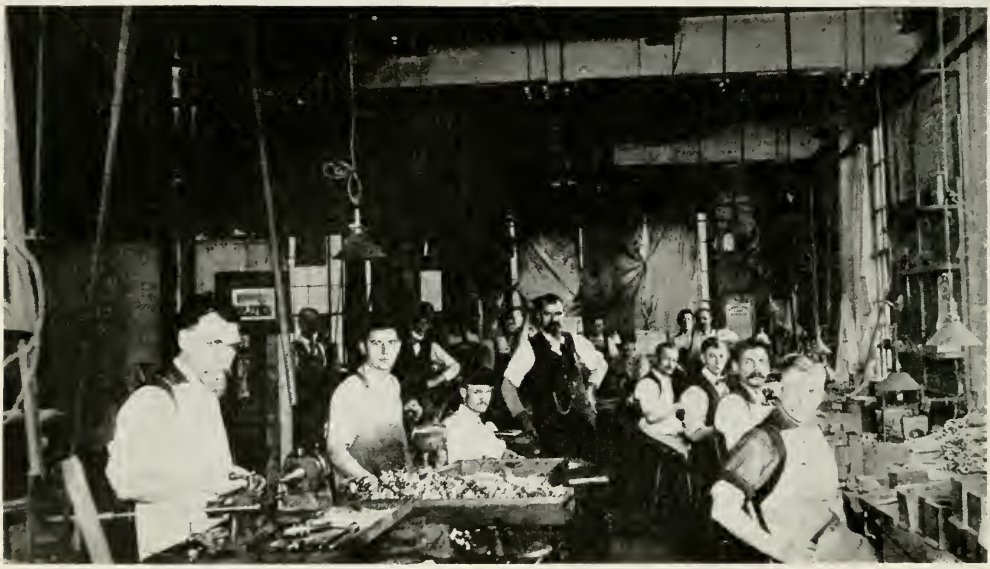
The patent compromise left the



"Clinton Street," Western Electric's Chicago manufacturing plant from 1883 to 1908

Western Electric Manufacturing Company greatly expanded but without a license to manufacture Bell telephones. Edison had just invented his incandescent lamp, and motors and generators heralded the dawn of the new power age. Gen. Stager and Enos Barton had wisely followed this progress, even counseling the inventors of the new electrical equipment developments. So they devoted a portion of the company's facilities to making light and power apparatus, while continuing to manufacture switchboards and such telephone equipment as had not been involved in the patent controversy.

About 1881, it became apparent that future progress in the telephone art would depend upon high-quality standardized equipment. Since Western Electric had pioneered much electrical equipment and telephone apparatus, such as the Scribner switchboard, the company was regarded as the best qualified manufacturer to effect standardization of Bell telephone equipment. And so early in 1881, it was arranged between Gen. Stager, then Western Electric president, and Theodore N. Vail, at that time general manager of the American Bell Telephone Company, for the Bell organization to buy a minority interest in Western.



A SCENE in the Clinton Street plant about 1895

Enter the Bell System

IN NOVEMBER, 1881, Western Electric and Bell officials formed the $1,000,000 Western Electric Company of Illinois. The new corporation acquired full ownership of the Gilliland Electrical Manufacturing Co., of Indianapolis, and the Charles

Williams, Jr., Company, of Boston, and became the manufacturing unit of the Bell System. The year 1882 saw the signing of the manufacturing contract between Western Electric and the parent corporation.

Gen. Stager's distinguished career ended with his death in 1885. William S. Smoot, of the Remington Arms Company, succeeded him as Western Electric's president, but lived only one year. In 1886 Enos M. Barton, co-founder of the Company, became president. Western Electric had become one of the largest units in the Bell System, and its electrical manufacturing business had been extended to foreign countries under the supervision of that "first stenographer," F. R. Welles.

The announcement about 1890 that America would hold a World's Fair in Chicago in 1892 led the Bell System to undertake construction of a record-breaking long distance circuit over the 900 miles between New York and Chicago, to be ready for the opening of the Fair. The circuit was personally opened by Alexander Graham Bell during 1892 and was in full operation several months before the delayed World's Columbian Exposition opened in 1893.

A SCENE in the hand set department at the Hawthorne Works before the war

The Fair seems to have brought about an emphasis on sales activities which was the beginning of the Western Electric Company's organized selling, a new departure in its domestic system of merchandising. By 1900 Western's increasing business in power apparatus and electrical supplies had created for the company a substantial purchasing power, and it was evident that if the purchasing

power of the various telephone companies was combined with the purchasing power of the Western Electric Company, a substantial advantage in the buying for the whole System would result. This plan was first discussed by H. B. Thayer, manager of the company's New York branch, and Theodore Spencer, general superintendent of the Bell Telephone Company at Philadelphia; and the first supply contract was signed with the Philadelphia company in 1901. By 1913, supply contracts had been executed with all the associated telephone companies in the Bell System.

In 1897 the expansion of the business made it necessary to erect a new building at 463 West Street, to serve as the New York headquarters of the business and to house the New York shop. The power apparatus manufacturing business, located in Chicago, continued to expand, and numerous installations of important projects were made. Many new distributing houses were also opened.

"Hawthorne" Is Started

In 1902 Mr. Thayer was elected vice president, and in 1903 the construction of the first buildings of the great Hawthorne Works at Cicero, Ill., was authorized. In 1905 the power apparatus shops were moved from Clinton Street to Hawthorne. By this time the country had 4,000,000 telephones. Within a year Western Electric became the largest electrical manufacturing and distributing organization in the world, with sales of $65,000,000 in 1906. In that same year the company established a pension system which was one of the earliest in the manufacturing industry.

The sudden economic reversals of 1907 brought a financial panic which threatened the nation's banking system and all important industries. There was grave possibility that some telephone companies might have to suspend service.

In that crisis Messrs. Barton, Thayer, and Welles by brilliant services saved the company and helped relieve the strain upon other Bell System units hard hit by local banking difficulties. Mr. Thayer continued to furnish telephone supplies on an extended credit basis, Mr. Welles purchased American currency in Europe and brought it to this country to support the payroll, and Mr. Barton helped restore confidence by coming to New York and offering New York bankers reimbursement for borrowings in advance of due dates.

When, in 1907, Theodore N. Vail became president of the American Telephone and Telegraph Company, which had become the parent company of the Bell System in 1900, he found it necessary to reorganize not only its finances and general management but its engineering and research work as well. In the summer of 1907 the development personnel of the American Company, with their laboratory, which had been maintained in Boston, were removed to New York, and were merged with a similar group maintained in that city by the Western Electric Company. At the same time, a considerable part of Western's group of development engineers in Chicago was removed to New York to form a part of the new centralized unit at 463 West Street, under the direction of Chief Engineer C. E. Scribner.

Mr. Thayer was elected president of the Western Electric Company in 1908 and Mr. Barton became chairman of the board. The nation had well over 6,000,000 telephones and the Hawthorne plant had continued to expand through almost uninterrupted construction of additional buildings. Western Electric had carried the instruments of communication and many other electrical devices to far parts of the world.

By 1909 the increasing growth of the telephone manufacturing business indicated the wisdom of selling Western Electric's extensive power apparatus manufacturing business to the General Electric Company. Coincident with this sale, an agency arrangement for the distribution of General Electric power apparatus by Western was consummated.

W. E. in World War I

World War I started in 1914, and the United States began to be involved in diplomatic incidents during 1915. In 1916 the engineers of the Western Electric Company and the A. T. & T. Co. conducted a mobilization test, in coöperation with the U. S. Navy, establishing a nationwide network of communications using telephone, telegraph, radio, and teletypewriters to communicate among points on this continent and ships deployed in adjacent waters. This system was used by the Government after we entered the war in April, 1917, and one of its offshoots was the first

"Distribution" at the old Philadelphia distributing house about 1904

ship-to-shore radio telephone equipment made by Western and supplied in quantity to the Navy.

THE USE OF airplanes as a military weapon in that war developed a need for means of communication between plane and ground, and Western Electric produced the first radio telephone equipment for this purpose. Mr. Thayer became a member of the U. S. Aviation Board. Another important Western Electric contribution to World War I was the production of large quantities of telephone equipment for the various Army cantonments built in many parts of the country. Western Electric's British company developed the "Nash Fish," a submarine detector for which its inventor, G. Howard Nash, was decorated by the British Government. Total sales of Western Electric equipment to the U. S. Government amounted to $31,918,000 during that war. That was thought to be a record no future emergency would ever see surpassed.

When the war ended, November 11, 1918, Western Electric again turned to the pursuits of peace. In 1919 Mr. Thayer was chosen as president of the American Telephone and Telegraph Company, succeeding Theodore N. Vail. Charles G. DuBois was elected Western Electric's president.

In 1922 a complete separation was effected between the Western Electric organizations handling Bell System telephone business and its electrical supply business. In 1923 construction was started on the great Kearny Works in New Jersey. The first production there in 1925 was of telephone cable. In that same year, Walter S. Gifford, who began his Bell System career with Western Electric in Chicago in 1904, became president of the American Telephone and Telegraph Company.

Western's Full-time Job

THE BELL SYSTEM'S rapid growth and the need for immense quantities of dial telephone apparatus and equipment made it evident that serving the System was a full time job for the Western Electric Company. Consequently, in 1925, Western incorporated the Graybar Electric Company, named in honor of Enos M. Barton and Elisha Gray, with Albert L. Salt as its president, for the purpose of segregating into a separate company its electrical supply business. In 1928 the common stock of this corporation was sold to its employees—a new departure in large corporation ownership. Western's interest in Graybar was thereafter represented only by preferred stock, the last of which was paid off and retired by Graybar in 1941.

During 1918 Western's foreign companies had been transferred to a newly organized subsidiary company called the International Western Electric Company. As an additional step to concentrate on the expanding Bell business, Western in the year 1925 sold the International Western Electric Company to the International Telephone and Telegraph Company, although retaining its interest in the Northern Electric Company, which serves the Bell Telephone Company of Canada.

As a measure to promote technical progress in communications, the Western Electric engineering department at West Street was incorporated

in December, 1924, as the Bell Telephone Laboratories. Its ownership is shared equally between the A.T.& T. Co. and Western Electric. Dr. Frank B. Jewett became its first president in 1925, and was succeeded in 1940 by Dr. Oliver E. Buckley.

As an outgrowth of telephone research, Bell Laboratories developed and Western produced, in 1926, equipment which brought to the world a notable advance in entertainment and education: the first commercially practicable talking motion pictures. The screen at last had become articulate and the long titles and printed dialogue disappeared.

The production of step-by-step and panel dial switching for the replacement of manual central office equipment continued. Later a third system, today's crossbar, was developed and placed in production.

In 1926 Mr. DuBois retired as Western Electric's president, and was succeeded by Edgar S. Bloom, then vice president of the A.T.& T. Co. Under his presidency Western Electric produced the equipment for the A.T.& T. Co. which resulted in the inauguration of commercial transatlantic radio telephone service in 1927. Under Mr. Bloom's guidance Western expanded its efforts in the production and installation of dial central office equipment. In 1929 the construction of a third great manufacturing plant, the Point Breeze Works, in Baltimore, Md., was commenced. The United States had

EFFICIENCY is the keynote of Western Electric's present 29 distributing houses

never seemed more prosperous, and the number of telephones had grown to 20,000,000.

But, as in 1907, economic forces halted the pace of this prosperity. In September, 1929, occurred a crisis on the New York Stock Exchange which was followed during the next four years by a series of economic and financial upsets, with many bank failures in Europe and this country. From this dark and trying period, Western Electric emerged stronger than at any previous time.

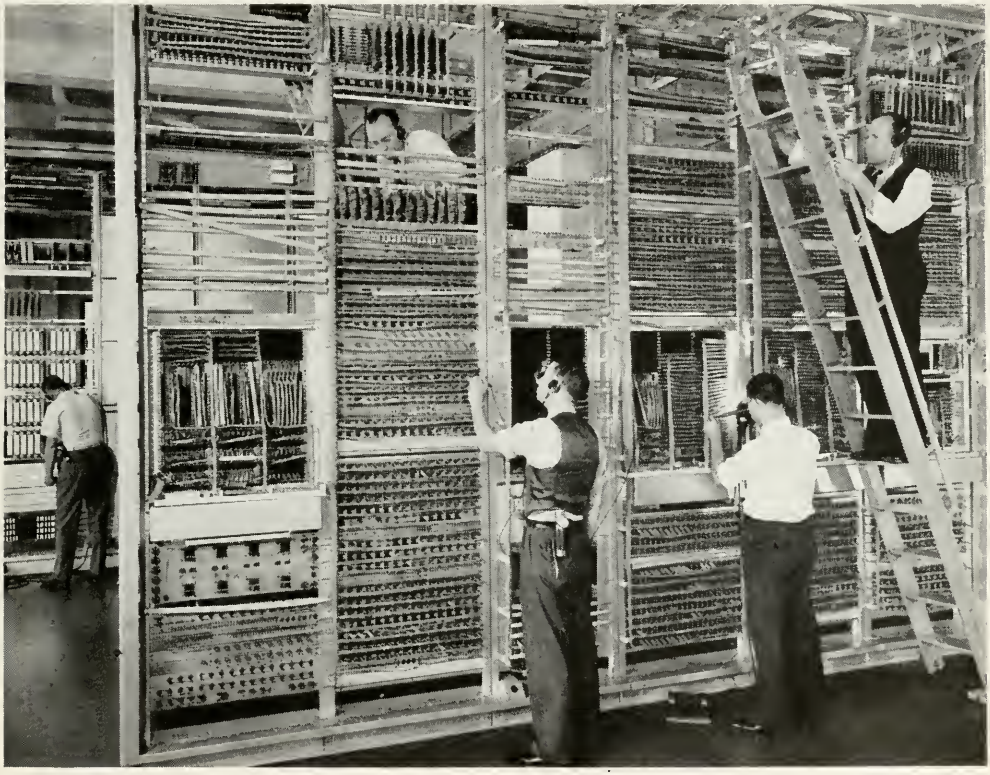
In 1931 the Bell System inaugurated its teletypewriter exchange service (TWX), whereby any subscriber in the TWX network could be switched to any other subscriber. To insure an adequate supply of equipment for this purpose, Western purchased the Teletype Corporation, Chicago, in 1930.

The following year Western acquired the Nassau Smelting and Refining Company at Tottenville, N. Y., in order to handle efficiently the increasing amounts of non-ferrous scrap materials removed from the Bell System plant.

In June, 1939, Western Electric was authorized by our Government to proceed with the manufacture of sub-

An installation force, and a typical switchboard in process of being installed, about 1900

stantial quantities of airplane radio equipments. When Germany invaded Poland two months later, it was evident that Western's facilities were destined to play an important part in the coming world-wide struggle.



WESTERN ELECTRIC installers at work on a modern crossbar central-office switching installation

The Threat of War

AT THE END of 1939 President Bloom retired, and Vice President Clarence G. Stoll was elected president of the Company on January 1, 1940.

The beginning of Mr. Stoll's administration witnessed alarming developments of World War II. By mid-summer Germany had subjugated most of Europe. The British retreat from the Continent and the fall of France made it clear that Great Britain could not long withstand the German menace without enormous industrial aid.

The United States stepped up its defense program in September, 1940, with compulsory military training of men. This program called for a vast national chain of military camps and bases, for which the Associated Companies called on Western to provide many new and complex commu-

nication equipments. During this period Western Electric's experienced forces were busily engaged in the manufacture and installation of a great range of emergency and unusual services. They included telephone equipments for training camps, shipyards and industrial plants. More elaborate facilities were provided for the Army's mammoth Pentagon building in Washington, and new long distance telephone lines were furnished for installation throughout the country and to Alaska.

Meanwhile, men from Western Electric's manufacturing department scoured the land to find new plant facilities. Western needed more manufacturing space and hundreds of subcontractors, as the company was expected to serve as the "pilot" plant for the communications equipment industry.

Acute shortages of material threatened the country's war production. Western Electric purchasing agents went in search of new sources of raw material supply and had to find substitutes for many materials required by the Bell System to maintain its vital network of communications—since materials formerly used for this purpose had been commandeered for war use.

COURAGEOUS WORK of employees, as in many another emergency, saved the San Francisco distributing house from the fire of 1906

Those men who volunteered or had been drafted for the armed services had to be replaced, requiring employment of thousands of women for jobs ordinarily done by men. Since 1873 women had worked for Western, but usually on such lighter jobs as coil winding, assembly, relay adjustment, or clerical work. Now they were to do welding, drilling, carpentry, truck driving, even operate the giant cranes used to pick up cable

reels and heavy steel. Much other work of a technical nature, such as electrical testing, also had to be done by women. They had to be trained by thousands.

Daily the European war picture grew darker, but almost hourly Western Electric's production grew potentially larger as the employee training program became more effective. The Company's Government sales, which had been about $3,500,000 in 1940, climbed toward a 1941 volume of $41,000,000.

The battle lines of this world-wide war circled the earth. The United States and its Allies had need to coordinate offensives by air, land, and sea all over the world. The speed of the new mechanized warfare required communications equipment upon a hitherto undreamed of scale. Instantaneous and constant communications were imperative.

Reliable aviation radio transmitters and microphones had to be built to withstand the heat of a desert sun at one moment and the subzero temperatures of the stratosphere at another. Telephones and other instruments must endure the destructive effects of tropical fungi and in some cases complete immersion in salt water.

The United States and her Allies needed telephones, field switchboards, cable; radio telephone sets for tanks, planes, and ships; and other apparatus in enormous quantities throughout the world.

In 1942 Western Electric answered these needs with production which was reflected in sales to the Government of $309,000,000. In 1943 they reached $596,000,000. The Company's total sales, including sales to the Bell System of materials essential to war activities, amounted to $557,000,000 in 1942 and $700,000,000 in 1943.

Arsenal of Communications

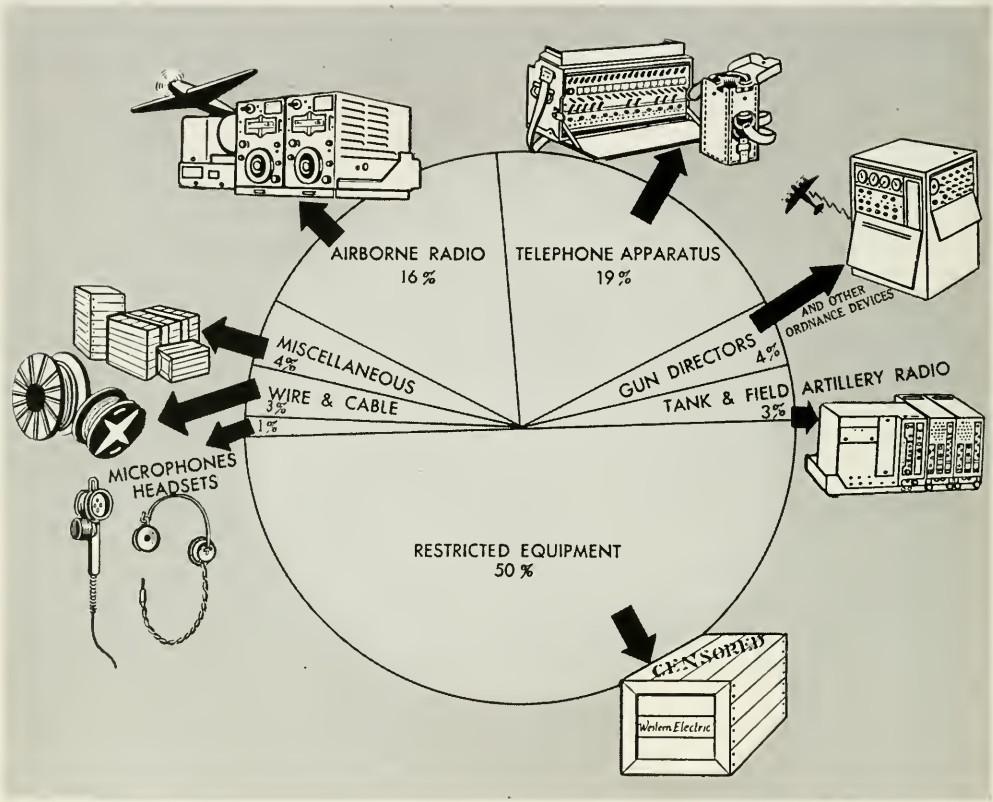
BEGINNING with the present war effort and up to the end of 1944, the men and women of Western Electric (and women now constitute more than half the force) had produced:

- 58,000 miles of Spiral-4 cable.
- 2,912,000 miles of wire in exchange cable of various sizes.
- 909,000 miles of wire in toll cable of various sizes.
- 22,700 miles of field wire.
- Packaged "C" carrier equipments with a value of $22,000,000.
- 601,135 airplane radio receivers.
- 425,545 airplane radio transmitters.
- 46,657 combination airplane receivers and transmitters.
- 1,299,993 head sets for aviators and tank crews.
- 1,441,377 microphones.
- Large quantities of various types of Radar.
- Electrical gun directors.
- Thousands of teletypewriters, including many adapted to radio.
- 22,800 switchboard positions of 22 varieties. (This quantity does not include those furnished telephone companies for installation in the Pentagon Building and in the hundreds of home-front military bases and war factories.)

These production statistics provide only a partial index to this war production, because about half of it is now the manufacture of "restricted" weapons, about which no slightest detail may be mentioned. However, as some indication of the nature of Western's collaboration and that of Bell Telephone Laboratories with the Government, it can be told that on

January 1, 1943, there were *92 major war projects* on Western's books. In 50 out of the 92 projects the devices were suggested to the Government by Western Electric and Bell Laboratories. In 78 the Bell Laboratories did the research development. In 79 they furnished the production design, and of all 92 projects Western was the manufacturer.

Today Western Electric products are helping our fighting forces turn the tide of battle on all the world's fighting fronts. In 1944 its sales to the Government were more than $788,000,000. In addition, during 1944 Western Electric's sales to the Bell System amounted to more than $120,000,000, practically all of which is applicable to the war effort. For the five year period 1940 to 1944 inclusive, the company's total sales to the Government amount to more than $1,700,000,000—which exceeds total sales to all customers during the first 50 years of its existence. Western Electric has met schedules which looked humanly impossible to meet. Nineteen of the 29 distributing houses converted repair shop facilities



THESE major items made up Western Electric's more than $788,000,000 of sales to the Government in 1944

to assist the three major Works. The company has leased 22 satellite plants in 15 cities, and has made subcontracts and other purchase arrangements with nearly 15,000 subcontractors and suppliers.

Western Electric's history has been inseparable from the record and growth of these United States. Seventy-five years ago a dozen highly skilled craftsmen competed for superiority of workmanship amid the quaint atmosphere of the Gray and Barton shop. That little band has grown into the present Western Electric family of 95,000, with activities almost as diverse as industry itself.

Diverse as are these war-time activities, Western Electric's responsibilities focus, in times of peace, almost entirely on its three-fold job as manufacturing, purchasing, and supply unit for the Bell System. From its factories and through its distributing houses it makes available the innumerable items out of which the telephone plant is constructed, and at the distributing houses used equipment is also repaired and reconditioned. Its skilled installation forces put in place and test the System's new central-office equipment through which the connection of telephone lines is accomplished.

Of 75 years of history, more has been omitted from the foregoing pages, obviously, than they have been able to tell. Implicit are Western Electric's accomplishments in public service for many years as first an independent manufacturer and then for 63 years an integral part of the Bell System. In the present struggle, the company is the world's largest producer of communications and electronic equipment for war, and Western Electric's men and women are making every day an incalculable contribution to Allied victory.

We have seen a nationwide poll which indicates that the public thinks big business has made big money out of the war. We doubt if that is true. We think the figures after renegotiation and taxes will show that never was so much produced for so small a profit.

But whether that is right for all big industry or not, we do know the Bell System has not profited by the war. We have never before handled as much business as we are handling now, and our earnings on the money in the business are lower than they have been in thirty years—except for the four worst years of the depression.

Not only are we not profiteering on the war, we are not making even normal earnings. When the war is over, we want to do our full part in providing the prosperity and jobs and opportunities which we all hope to see in this country. This will mean a lot of work for a lot of people—and an ever-improving telephone service for all.

An announcement on The Telephone Hour radio program.

For the Record

A selected list of happenings, of System interest, occurring between Nov. 1, 1944, and Feb. 28, 1945

RATES for overseas telephone service to Hawaii from about two-thirds of the states of this country were reduced on November 1. Rates to the Bahamas from about one-third of the states, and to Jamaica from anywhere in the country, were reduced on the same date.

On December 1, rates for overseas telephone service from this country to Bermuda were reduced.

By a resolution passed December 29, the National War Labor Board established a National Telephone Panel. The Panel, unless the Board otherwise directs, shall have jurisdiction of all voluntary and dispute cases involving the telephone industry. The Panel shall have authority to refer to a Regional War Labor Board any voluntary case which it deems can be more effectively handled by a Regional Board.

The Senate confirmed on January 18 the nomination of Paul A. Porter, former director of publicity for the Democratic National Committee, as a member of the Federal Communications Commission. Mr. Porter will serve as Chairman of the FCC.

Who's Who & What's What

(*Continued from page 211*)

the called telephone, the telephone engineer combines technical skill with common sense. From 1916 to 1922 RALPH MABBS spent most of his waking hours in the long distance offices at St. Louis and other cities of the southwestern part of the country as assistant traffic chief and division traffic engineer for the Long Lines Department. In 1923 he came to the O. and E. Department of A. T. & T., where he adapted the principles of trunking to the "coefficient" method of measuring operator work volumes now in use throughout the Bell System and in some foreign countries. The year 1926 found him again in traffic field work, in the Upstate Area of the New York Telephone Company. In 1929 he came back to the O. and E. Department, where he has since been engineer, toll traffic engineer, traffic methods engineer, and traffic facilities engineer.

THE PLACE of the Western Electric Company in the Bell System scheme of things—as manufacturer, supplier, installer of central-office equipment—is so generally understood that FRANK H. LOVETTE has been able to devote his pen to many of the less well-known aspects of his company's 75-year history. He joined Western Electric in 1943, where his post is now that of Historian. His previous career includes being, among other things, publisher of a daily newspaper in the south, executive officer of the old Federal Radio Commission, secretary to a member of congress, editor of a radio journal, a contributor to magazines, and the author of three books.

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